Mineral Land Surveying

JAMES UNDERHILL, Ph.B.

Mineral Land Surveying

A technical treatise on the surveying and patenting of mineral land, designed for the use of Deputy Mineral Surveyors and Students of Mining Engineering, with an appendix of contributed notes of interest.

BY

JAMES UNDERHILL, PH. D.

MINING ENGINEER.

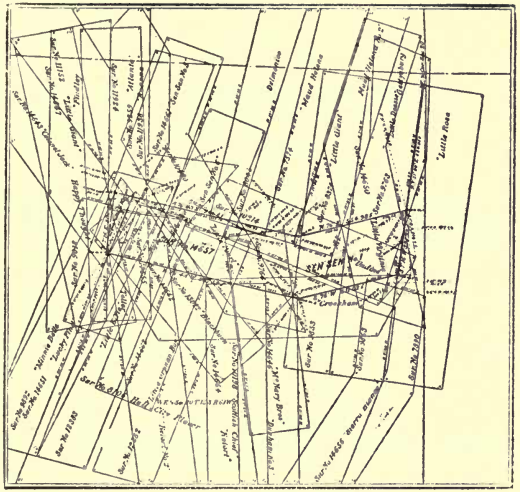
U.S. Deputy Mineral Surveyor for Colorado.

1906

THE MINING REPORTER PUBLISHING COMPANY

DENVER, COLORADO, U. S. A.

COPYRIGHT 1906 BY
THE MINING REPORTER PUBLISHING COMPANY
DENVER, COLORADO



The accompanying plate is reproduced for the purpose of showing the tangled state of affairs that the Deputy United States Mineral Surveyor is sometimes concerned with. The plate represents an actual case in the patenting of a claim and shows numerous conflicts.

Table of Contents.

CHAPTER I.

DIRECT SOLAR OBSERVATIONS.

Placing the Sun—Derivation of Formula—Examples of Observations and Figuring—Latitude Observations—Errors in Observations of Latitude—Second Formula 1-18

CHAPTER II.

SOLAR ATTACHMENTS.

The Shattuck Solar—The Burt Solar—The Berger and Saegmuller Solars 19-41

CHAPTER III.

MEASUREMENTS.

Traversing—Measuring—Stations—Slope Measurements—Obstacles—Closing Lines in Traversing—Rule for Azimuth..... 42-51

CHAPTER IV.

LOCATION SURVEYS.

Lode Locations—Note Book—Location Certificate—Angular Claims—Relocation and Amended Location—Mill Sites and Placers—Double Meridian Distances — Tunnel Sites — Legal Subdivisions — Tracing Vein Extensions..... 52-85

CHAPTER V.

PATENT SURVEYS.

Surveying for Patent—Angles from Courses—Patent Figuring—Area Statement—Miscellaneous on Patents—Adverses and Protests..... 86-123

CHAPTER VI.

PATENT FIELD NOTES.

Patent Field Notes.....124-158

CHAPTER VII.

LAND OFFICE AND RECORDS.

Office United States Surveyor General—Land Office Regulations—Public and Private Records.....159-187

CHAPTER VIII.

EXAMINATION FOR COMMISSION UNITED STATES DEPUTY MINERAL SURVEYOR.

Placer Calculations—Lode Line Calculation—Subdivision of Section—Examination Questions, South Dakota, California, Oregon.....188-204

APPENDIX.

Correspondence—The Patenting of Mineral Lands...205-218

Acknowledgements

This reprint edition of "MINERAL LAND SURVEYING" was printed from a copy of the book loaned by F. D. Uzes, author of surveying literature, historian, and Land Surveyor.

Printing and advice was provided by Jan Maschino at Edwards Brothers, Inc., 2500 South State Street, Ann Arbor, MI 48106.

Published by Landmark Enterprises, 10324 Newton Way, Rancho Cordova, CA 95670.

PREFACE.

IN the work which follows an attempt has been made to describe the methods used at the present time in the survey of mineral lands in the western portion of the United States. Only as much of general surveying has been given as is necessary to a clear understanding of the subject, and the reader is referred to the various text books on surveying for all information of a general nature. The reader is also referred to Morrison's Mining Rights for the treatment of the purely legal points.

It will be impossible to give credit to all those who have assisted the writer either during the period when the work was appearing as a serial in Mining Reporter, or in its final incorporation in book form. To all those who have assisted, the writer wishes to express his heartfelt thanks, and especially to Professors L. E. Young, E. M., and A. J. Hoskin, Mech. E. of the Colorado School of Mines; Professor Mark Ehle, E. M., of the South Dakota School of Mines; N. H. Brown, E. M., U. S. Deputy Mineral Surveyor, formerly Chief of the Mineral Division, and M. E. Blake, the present Chief of the Mineral Division, Office U. S. Surveyor General for Colorado. The writer is also indebted to H. G. Moulton, E. M., and P. P. Barbour, E. M., U. S. Deputy Mineral Surveyors, for many valuable suggestions, and to William Hyland for assistance in the calculations.

The writer in conclusion cannot acknowledge too strongly the assistance of his wife, which has been invaluable to him.

CHAPTER I.

Direct Solar Observation.

Of the applications of plane surveying to the survey of mineral lands, no one is more representative or has been more greatly perfected in the West than the use of the sun to determine the bearing of a given line. For many years bearings were determined by the use of various solar attachments but of late years the method known as the direct observation seems to have almost entirely taken their place. While with great care any one of the several solar attachments on the market will give fair or even good results, they are all relatively expensive, fragile and with one exception, easily thrown out of adjustment. With the method known as the direct observation no attachment is needed to the ordinary transit provided with a vertical arc or circle, preferably the latter, and no adjustment has to be considered other than those necessary to use in every transit in mineral land surveying.

As the exact determination of the bearings of lines is probably more important in mineral land surveying than in perhaps any other branch of engineering, disregarding of course geodetic work, it will be taken up in detail.

To determine the bearing of a line by direct observation, the transit is set up as solidly as possible and carefully levelled. The line whose bearing is to be determined may be considered 0° and the upper plate set at 0°, or if the bearing is approximately known, the upper plate may be set at the assumed bearing to be afterwards corrected. If more convenient, the assumed bearing of a line to some prominent object may be taken, and the first course required on the survey deflected from this line. The upper plate is then loosened and the telescope pointed at the

sun. The sun may be observed in various ways, for example through a colored glass placed over the eye-piece to which may be added a prism when the sun is very high. This colored glass may be very conveniently placed in the sliding cover of the eye-piece and is thus always ready for use. As this method involves the attachment of the colored glass, and also when the sun is high some personal discomfort as regards the position of the head, a card, sheet of paper, or better the brown back of a note-book, which latter does away with the glare on a white surface, may be used. On this surface, preferably held by the assistant, the cross wires are first focused and finally the sun is brought into the proper position, by the aid of the tangent screws.

A Davis screen is a piece of apparatus attached to the telescope to answer the same purpose as the card mentioned above, and its use leaves both hands free to manipulate the instrument. Otherwise it is of no great advantage.

In regard to placing the sun with reference to cross wires, there are many opinions. In most treatises we are instructed not to bisect the sun as in Fig. 1A, but to place it in one quadrant, as in Fig. 1B, as it can thus be observed more accurately. While this is perfectly true, especially with inverting instruments, a correction for semi-diameter of the sun must be made, and the operation is liable to be somewhat confusing to the beginner. The student is therefore advised at first to divide the sun into quadrants by the two cross hairs (Fig. 1A) leaving the method of placing the cross hairs tangent until proficiency is secured. As an error of one minute in placing the vertical cross wire causes an error of one minute in the resulting azimuth, while an error of one minute in placing the horizontal wire causes an error of several minutes in the result, it might be well to place the sun as in Fig. 1C. The reason for this will readily be seen on examining the ex-

amples which follow. The sun in very accurate work is sometimes placed in a rectangle or other arrangement of cross wires, but in ordinary work these are unnecessary refinements.

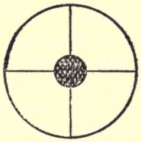


Fig. 1 A.

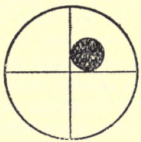


Fig. 1 B.

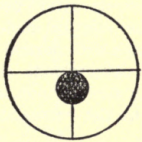


Fig. 1 C.

Fig. 1 D.

Another very exact method of placing the sun in the direct observation is to place the sun tangent to the cross wires first in the N. E. corner with the telescope normal and then in the S. W. corner with the telescope inverted. These are the best positions in the morning. In the afternoon the other two quadrants had best be used in order that the sun may be moving in the same direction with reference to the cross wires. The average of the two vertical and two horizontal angles are used in each case in the subsequent calculations and in this way all consideration of the semi-diameter of the sun is avoided. At least two sets of such observations must be made, otherwise there is no check.

In an instrument provided with stadia wires care must be taken not to confuse these with the horizontal cross

wire. It is also well, not to assume, without a trial, that the stadia wires are each equally distant from the horizontal cross wire.

If the stadia wires are correctly placed they should be 0° 34′ 22″ apart, and each 0° 17′ 11″ from the center horizontal wire. As the sun's semi-diameter varies round 0° 16′ the stadia wires may be used with advantage to place the sun with a very slight probable error. (Fig. 1 D.)

We will assume that the sun has been bisected. The vertical and horizontal circles are then read and noted and an observation made with the telescope inverted, assuming that the first observation was made with the telescope normal. By averaging the two results all errors of adjustment or in levelling the instrument are obviated. As a check a number of observations may be made on the sun, and the writer finds that two each with normal and inverted telescope are sufficient. The observations should not be made within two hours on each side of noon, nor when the sun is too near the horizon, as the correction for refraction is then too great.

The direct solar observation depends on the solution of a spherical triangle (see Fig. 2*) whose sides are all known, and whose angle between two planes is desired. These planes, as can be seen from the figure, are one, observer, zenith, pole; and the other, observer, zenith, sun. In our work we have first the latitude, distance pole to horizon or zenith to equator, and therefore the co-latitude (90°—latitude) for one side, or in other words we have from pole to zenith; we have the declination, distance of the sun above or below the equator and therefore the co-declination (90°—declination) that is from pole to sun, and we finally get the altitude and thence the co-altitude (90°—

*Redrawn from the Bulletin, Colorado School of Mines, January, 1901, "Determination of the Meridian by the Direct Solar Observation." Edward P. Arthur, Jr., E. M.

the altitude) by the solar observation with the transit as described above. In Fig. 2 the sun is shown by solid lines north of the equator and by dotted lines south of the equator. This also showing its position before noon. This triangle may be solved by any one of the various formulas

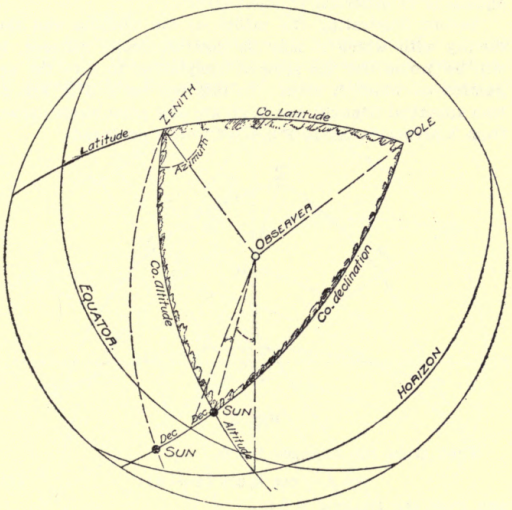


Fig. 2.

found in every treatise on spherical trigonometry.

The best formula, however, for the direct observation is that derived by John G. McElroy, of Breckenridge, Colo-

rado, and given in the Michigan Engineer's Annual for 1889, page 62, as follows:

$$\text{"Cos } Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a,$$

which is simply a modification of one of the fundamental equations of spherical trigonometry.

Before illustrating the utility of the formula and the facility with which it may be logarithmically reduced, it will be proper, for the sake of completion, to give the argument on which it rests. To this end let P Z S, Fig. 3, be a spherical triangle, and K an arc of a great circle drawn from Z perpendicular to P S,—(or to P S produced).

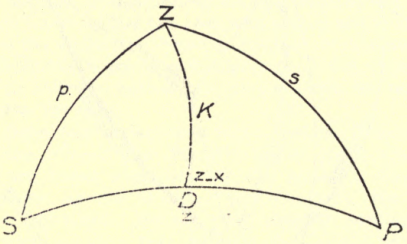


Fig. 3.

Then from the triangle P Z D,

$$\cos s = \cos k \cos (z - x): \qquad (1)$$

and from the triangle S Z D,

$$\cos p = \cos k \cos x \qquad (2)$$

Eliminating cos k, we find

$$\frac{\cos s}{\cos p} = \frac{\cos (z-x)}{\cos x} = \cos z + \sin z \tan x. \qquad (3)$$

But, from S Z D, cos S = tan x cot p;

$$\text{whence, } \tan x = \frac{\sin p}{\cos p} \cos S. \qquad (4)$$

Placing this in (3) there results

$$\frac{\cos s}{\cos p} = \cos z + \frac{\sin p \sin z}{\cos p} \cos S;$$

$$\text{or, } \cos s = \cos p \cos z + \sin p \sin z \cos S \qquad (5)$$

This is the above mentioned 'fundamental equation.' It asserts that the **cosine of either side of a spherical**

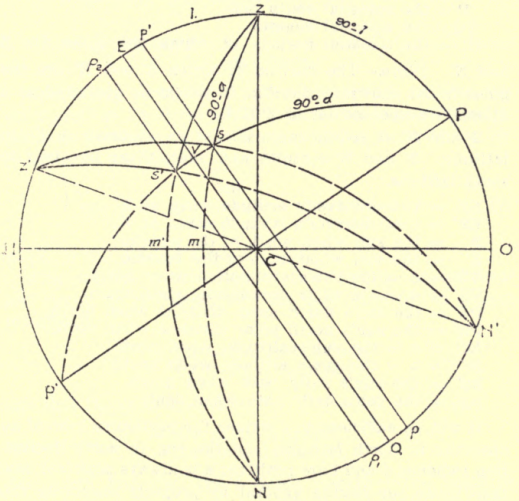


Fig. 4.

triangle equals the product of the cosines of the other sides, plus the product of the sines of those sides into the cosine of their included angle. To apply it to the derivation of our solar formula let us consider Fig. 4, which represents the four astronomical triangles, PZS, PZS', P'Z'S, and P'Z'S', projected on the plane of the meridian PNHZ. In a. m. observations the azimuth angles at Z or Z' will be estimated from the north to the right; in p. m. observations from the north to the left.

We adopt the following notation:

PP' = axis of the celestial sphere.
P = the celestial north pole.
P' = the celestial south pole.
EQ = the celestial equator.
HO = the celestial horizon of which the poles are Z and N. (Note.—The horizon of which Z' and N' are the poles is not shown in the Fig.; it would be projected as a diameter perpendicular to Z' N'.)

Z and N = zenith and nadir of an observer in north latitude. Z' and N' = zenith and nadir of an observer in south latitude.

EZ = l = observer's latitude when at Z.
EZ' = l = observer's latitude when at Z'.
S = the sun when north of the equator.
S' = the sun when south of the equator.
VS = d = the sun's declination when north.
VS' = d = the sun's declination when south.
PS = the sun's north polar distance when north.
PS' = the sun's north polar distance when south.
MS = a = the sun's altitude when north.
M'S' = a = the sun's altitude when south.
pp' = the sun's daily path when north.
p_1p_2 = the sun's daily path when south.

It will be sufficient to consider the particular case of an observer in north latitude, and the sun in north declination (whence d and l are positive; a is always positive), and then make our results general by properly observing the signs of d and l.

The case assumed is illustrated by the triangle PZS (Fig. 4), in which—

$$PS = 90° - VS = 90° - d,$$
$$PZ = 90° - EZ = 90° - l,$$
$$SZ = 90° - MS = 90° - a,$$

and the sun's azimuth angle PZS is required. It is found thus: By applying the principle of which equation (5) is the enunciation to the angle PZS, we have—

$$\text{Cos PS} = \text{Cos PZ. Cos SZ} + \text{Sin PZ. Sin SZ. Cos Z;}$$

or, $$\text{Cos } (90°-d) = \text{Cos } (90°-l) \text{ Cos } (90°-a) + \text{Sin } (90°-l) \text{ Sin } (90°-a) \text{ Cos Z,}$$

whence, $$\text{Sin d} = \text{Sin l Sin a} + \text{Cos l Cos a Cos Z}$$

From this, $$\cos Z = \frac{\sin d}{\cos l \cos a} - \tan l \tan a. \qquad (6)$$

In (6) cos l, cos a, and tan a, are always positive, but sin d and tan l will respectively have the signs of d and l; hence to prevent mistakes it is advisable to write the expression in the form

$$\cos Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a, \qquad (7)$$

which is the desired solar formula.

With respect to the signs of the formula the surveyor has simply to remember that the first term of the second member is

$$+ \text{ for north declinations,}$$
$$- \text{ for south declinations,}$$

and that the second term is

$$- \text{ for north latitudes,}$$
$$+ \text{ for south latitudes.}$$

For north latitudes the formula always gives negative values for cos Z when the declination is south, and also

for such north declinations and values of a as render sin d less than sin l sin a; but when cos Z is negative, Z is greater than 90°, and hence the positive value of the cosine, as taken from the table of 'Naturals' is the cosine of (180°— Z), (i. e., of EZS, the azimuth from the south) for — cos Z = cos (180°— Z)."

As an example we will take the following series of direct observations on the sun, the first two with telescope normal, the last two with telescope inverted:

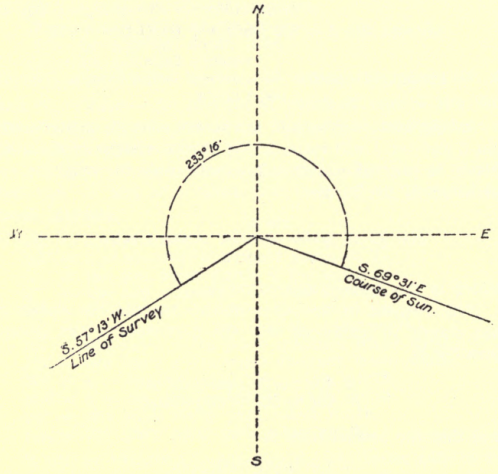


Fig. 5.

Angle to right from line to be determined.	Altitude of sun.
233° 16′ (See Fig. 5)	52* 51′
233° 33′	53* 03′
234° 01′	53° 18′
234° 17′	53° 29′

July 22, 1905, 10 a. m., latitude 39° 47′ north.

Dec. Greenwich apparent noon...20° 22′ 18.1″
Less 5 hours west..... 2′ 27.0″

20° 19′ 51.1″

Difference for 1 hour = 29.45
5

60 (147.25

Difference for 5 hours = 2′ 27″

Call 20° 19′ 51″ = 20° 20′

$$\text{Cos azimuth} = \frac{\sin 20° 20'}{\cos 39° 47'.\ \cos 52° 50^{*}\ \text{etc.}} - \tan 39° 47'\ [\tan 52° 50^{*}\ \text{etc.}$$

log sin 20° 20′ = 9.540931
log cos 39° 47′ = 9.885627

9.655304

9.655304
log cos 52° 50′ = 9.781134

log .7485 = 9.874170

*Corrected for refraction—always diminished.

log tan 39° 47′ = 9.920476
log tan 52° 50′ =10.120259

log 1.0984 = 0.040735
.7485

.3499 = nat. cos. 69° 31′ (course of sun)
233° 16′

302° 47′

9.655304
log cos 53° 2′ = 9.779128

log .7519 = 9.876178

log tan 39° 47′ = 9.920476
log tan 53° 2′ =10.123411

log 1.1066 = 0.043887
.7519

.3547 = nat. cos. 69° 14′ (course of sun)
233° 33′

302° 47′

360° 00′
302° 47′

S 57° 13′ W (See Fig. 5.)

9.655304
log cos 53° 17′ = 9.776598

log .7564 = 9.878706

log tan 39° 47′ = 9.920476
log tan 53° 17′ =10.127360

log 1.1163 = 0.047836
.7564

.3599 = nat. cos. 68° 54′
234° 01′

302° 55′

$$\begin{aligned} & & 9.655304 \\ \log \cos 53^\circ\ 28' &= & 9.774729 \\ \log .7596 &= & 9.880575 \end{aligned}$$

$$\begin{aligned} \log \tan 39^\circ\ 47' &= 9.920476 \\ \log \tan 53^\circ\ 28' &= 10.130263 \\ \log 1.1239 &= 0.050739 \end{aligned}$$

$$\begin{array}{rl} & .7596 \\ \hline .3643 = & \text{nat. cos. } 68^\circ\ 38' \\ & 234^\circ\ 17' \\ \hline & 302^\circ\ 55' \end{array}$$

$$\begin{array}{rll} & 13' & \\ & 13' & \\ & 05' & 360^\circ\ 00' \\ & 05' & 302^\circ\ 55' \\ \hline 4\ (& 36' & \text{S. } 57^\circ\ 5'\ \text{W.} \\ & 9' & \end{array}$$

Average course of line S. 57° 9′ W.

It will be seen that the cos and tan of the latitude and altitude, respectively, are found on the same line in the tables and are set down at the same time for calculation.

The sun's semi-diameter varies from about 16′ 15″ on January 1st to 15′ 45″ on July 2d and is found in the Ephemeris. The average, 16′ nearly, will do for ordinary work.

The refraction, always subtracted from the apparent altitude, is 57″ × tan zenith distance of sun or by table.

Mean Refraction (to be Subtracted from Observed Altitude) Barometer 30 inches; Thermometer 50° Fahrenheit.

Altitude.	Refraction.	Altitude.	Refraction.
10°	5'19"	20°	2'39"
11	4 51	25	2 04
12	4 27	30	1 41
13	4 07	35	1 23
14	3 49	40	1 09
15	3 34	45	58
16	3 20	50	49
17	3 08	60	34
18	2 57	70	21
19	2 48	80	10

The declination is taken from any ephemeris such as is published by many instrument makers. At Denver we are seven hours later in apparent time than Greenwich, one hour for each 15° of longitude, and this difference in time multiplied by the hourly difference given in the ephemeris is added or subtracted, as the declination is increasing or decreasing, to or from the declination given for Greenwich noon.

Latitude.

The latitude is taken from any good map, such as those of the United States Geological Survey, and carried from the initial point when necessary. One minute of latitude equals 6,070 feet, or one mile equals 52 seconds of latitude. A surveyor doing considerable work in one district will prepare a table showing cosines and tangents for latitudes likely to be of use, and thus avoid looking them up in a large table every time an observation is figured.

When the latitude is known approximately observations may be taken at equal intervals before and after apparent noon, and various figures for latitude tried till one is found which gives the same azimuth in the morning as in the afternoon. When the latitude is absolutely unknown, it may be found as follows: Set up the instrument in plenty

of time before apparent noon. Bisect the sun with vertical cross wire and either bisect it with horizontal cross wire, or place tangent. Follow the sun till it ceases to rise. Care must be taken in the observation to allow plenty of space through which the tangent screws may be moved, otherwise they are liable to give out at a critical

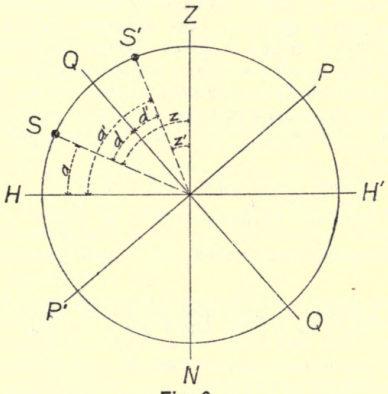


Fig. 6.

moment. As the instrument can not be reversed as in the case of the direct sight, it is well to level the telescope immediately after the observation and note the index error adding or subtracting it for the angle observed. In instruments with a movable arc, the arc had best be set at zero immediately after getting the sun. The telescope is then levelled and the angle read, thus avoiding errors incidental to settling of the instrument during a long observation.

When the observer is north of the equator the latitude

then equals the zenith distance plus the declination for apparent noon. Lat. = (90° — altitude*) + declination, when the sun is north of the equator, and Lat. = (90° — altitude*) — declination, when the sun is south of the equator.

When the observer is south of the equator the above is reversed.

In Fig. 6, which represents a section of the celestial sphere on the meridian, we have ZN Zenith to Nadir line, PP' line joining the poles. QQ the equator and HH' the horizon. While S and S' shows the position of the sun, Z and Z' the zenith distance, a and a' the altitude and d and d' the declinations, respectively, when the sun is south or north of the equator and the observer in north latitude. Example: October 20, 1905; 12 m.; Longitude 105° 30'+W.

Altitude sun's upper limb	= 40° 15'
Less refraction	= 0° 1'
Less semi diameter	= 0° 16'
Altitude sun's center	= 39° 58'

Declination Greenwich A. T.	= 10° 11' 50"
Diff. 1 hr. = 54.01. Diff. 7 hrs.	= 6' 30"
Declin. Longitude 105° 30'+W.	= 10° 18' 20"
Altitude sun's center	= 39° 58'
	50° 16' 20"
	90° 00' 00"
	50° 16' 20"
Latitude place of observation	= 39° 43' 40"

By inspection of the following table errors resulting from the use of erroneous data for declination or latitude may be found.

*(Corrected for refraction).

Errors in Azimuth for 1 Min. Error in Declination or Latitude.

No. of Hrs. from Noon.	For 1 Min. Error in Declination.			For 1 Min. Error in Latitude		
h m	Lat. 30° Min.	Lat. 40° Min.	Lat. 50° Min.	Lat. 30° Min.	Lat. 40° Min.	Lat. 50° Min.
0 30	8.85	10.00	12.90	8.77	9.92	11.80
1 00	4.46	5.05	6.01	4.33	4.87	5.80
2 00	2.31	2.61	3.11	2.00	2.26	2.70
3 00	1.63	1.85	2.20	1.15	1.30	1.56
4 00	1.34	1.51	1.80	0.67	0.75	0.90
5 00	1.20	1.35	1.61	0.31	0.35	0.37
6 00	1.15	1.30	1.56	0.00	0.00	0.00

By the use of the above table the amount of the azimuth error, resulting from the use of erroneous Declination or Latitude at the different hours of the day, may be determined.

If the South Polar Distance used be too great, the observed meridian falls to the right of the true South Point in the forenoon, and to the left in the afternoon, and vice versa if too small.

If the Latitude used be too great, the observed meridian falls to the left of the true South Point in the forenoon, and to the right in the afternoon, and vice versa if too small.

Another formula for direct sight, though not so convenient when many observations are to be worked out, but still useful as a check, is as follows:

$$\text{Sin } \tfrac{1}{2} A = \sqrt{\frac{\sin (S-L) \sin (S-h)}{\cos L \cos h}}$$

$$S = \frac{L+h+P}{2}$$

A = Azimuth of the sun.
L = Latitude of the place.

h = Altitude of sun less refraction.

p = Sun's polar distance = 90° + sun's declination when it is south and 90° − the sun's declination when it is north.

Example:

L = 40° 30′
h = 23° 05′
p = 107° 03′

170° 38′ ÷ 2 = 85° 19′ = S.

S — L = 44° 49′ S — h = 62° 14′
log sin 44° 49′ = 9.848091
log sin 62° 14′ = 9.946871
log 10 — cos 40° 30′ = 0.118954
log 10 — cos 23° 05′ = 0.036243

2)19.950159

log sin ½ A = 9.975079
½ A = 70° 46′
A = 141° 32′

180° — 141° 32′ = S 38° 28′ E Course of observed sun.

As A is here doubled all errors to this point are therefore doubled.

CHAPTER II.

The Shattuck Solar Attachment.

Fig. 7 is a sectional view in the plane of the Shattuck Patent Double Reflecting Solar Attachment, perpendicular to both reflectors and the pivot of the arm D.

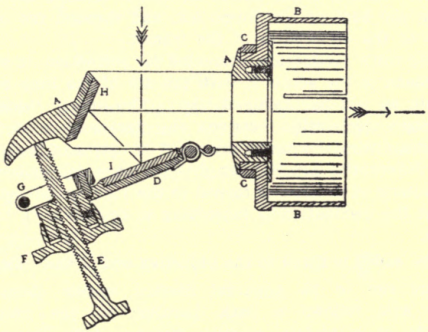


Fig. 7.

The frame AA, which carries the stationary mirror H, revolves about a main axis called the polar axis, coincident with the line of collimation, by means of a bearing in the cap B, and is held in place by two screws and a spring washer. It is provided with a clamp ring C, which may be clamped to the cap B by means of a clamp screw. A slow motion is obtained by means of a tangent screw and spring plunger (not shown) at the base of the frame AA.

D is a swinging arm pivoted in the frame AA as shown, and provided with a coiled spring which keeps the adjusting screw E constantly in contact with the surface of the lug on the outer end of the frame. This swinging arm carries the movable mirror I, the adjusting screw E for setting off the declination, the differential nut F for setting off the hourly change in declination and the clamp G for clamping the screw E when turning the nut F.

The ray of light from the sun or star enters from above, as indicated by the arrow, impinges upon the mirror I, is thence reflected to the mirror H, thence through the opening in the base of the frame AA, and through the object glass to the cross-hairs of the transit.

The sun's declination, corrected for refraction, is set off by means of the screw E with the aid of the limb of the transit, as will be explained later. The hourly change in the sun's declination between the first and subsequent readings during the day is corrected by means of the graduated differential nut F, each division of which represents one minute of arc and is turned to the right or left according as the declination is increasing to the north or to the south.

The cap B is fitted to the objective end of the transit.

The sun in its apparent diurnal motion about the polar axis follows a path parallel to the celestial equator at a certain angular distance from the poles. When this angle is set off by means of the solar attachment and the sight-line of the telescope is set at an angle with the horizon equal to the latitude of the place, it is evident that it is impossible to view the sun on the cross-wires and follow it by turning the attachment on its axis except the instrument be in the plane of the meridian with the sight-line parallel to the polar axis.

Determination of Meridian.

To Determine the Meridian with the Shattuck Patent Double-Reflecting Solar Attachment, assuming the sun's corrected declination for the day and hour of observation to be North 11° 26′:

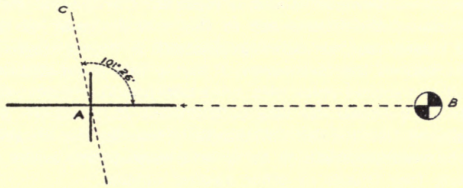


Fig. 8.

First. Sight at some point on the horizon (B. Fig. 8) with the solar attachment off, the telescope level and the vernier set at 101° 26′ (90° + 11° 26′), the corrected south polar distance, Fig. 8 being an illustration.

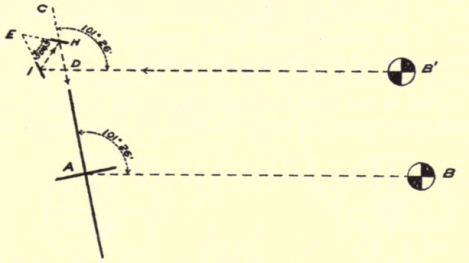


Fig. 9.

Second. With the lower plate clamped turn the vernier of the horizontal limb to zero and with the solar attachment in place, as shown by Fig. 9, sight the same object (B′ Fig.

9), bringing it to the cross-hairs by means of the adjusting screw E, which may then be clamped with the clamp G. Fig. 7.

Should the object sighted be less than about a mile distant—depending somewhat on the focal length of the telescope—allowance should be made for the distance from the axis of the instrument to the optical center of the solar attachment, as shown graphically in Fig. 9, where A is the axis of the instrument, B is the first point sighted, and B′ the second point with solar attachment in place; the angle CAB equals the angle CDB′ and the distance AD equals the distance BB′. With a little practice this distance can be readily estimated on distant fence posts, bricks in houses, tree trunks or other natural objects.

At great distances the distance B B′ becomes inappreciable and is ignored. The angle CDB′ will remain at 101° 26′ so long as the angle HEI (the angle between the reflectors) remains at 50° 43′ (101°+26′÷2), regardless of minor defects in the polar bearings of the attachment.

The lower clamp may now be released.

Third. Depress the objective of the telescope until the vernier of the vertical circle or arc is set at an angle equal to the latitude of the place of observation.

Bring the sun's image to the proper position on the cross-wires of the instrument by turning the transit on its vertical axis (using the lower clamp and tangent screw for

Fig. 10.

Fig. 11.

its fine adjustment) and the solar attachment upon its polar axis. The sun's image will be in the field of view

when the light from the fixed mirror is seen to pass exactly through the opening in the base of the frame.

After the sun's image has been bisected as shown in Fig. 10, the bisection may be successively checked by turning the tangent screw engaging the ring C, Fig. 7.

The axis of the telescope is now parallel to the earth's axis and the instrument is in the plane of the meridian with the vernier of the horizontal limb set at zero. The solar attachment may now be removed and the azimuth of any desired object taken.

If the transit is not provided with solar wires as shown in Fig. 10, set off on the vertical circle the latitude minus the sun's semi-diameter as given in the ephemeris, and

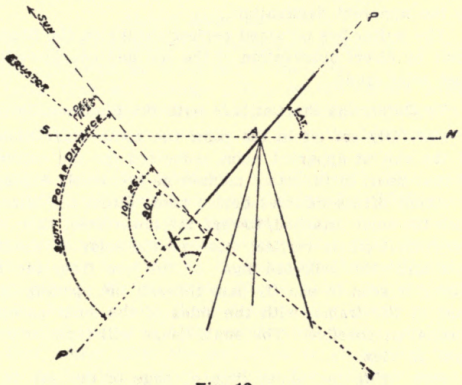


Fig. 12.

then bring the upper limb or edge of the sun to the intersection of the cross-hairs as shown in Fig. 11, which can be done with great precision.

Fig. 12 is a diagram illustrating the transit with solar attachment set in the meridian. A is the axis of the transit, PP' the polar axis, NS the meridian. The sun's declination being north, the south polar distance is 90° plus the corrected declination.

If the transit has a full vertical circle the errors of adjustment may be eliminated by taking the mean between normal and reverse observations, as in the case of the direct solar observation.

Observations on fixed stars for the meridian or latitude are made with the solar attachment in exactly the same manner as on the sun. There being no appreciable hourly change in the declination of the fixed stars, the refraction correction for the proper hour angle is applied directly to the apparent declination.

The writer has obtained perfect checks on the Shattuck solar by direct observation of the sun and considers it the best solar made.

To Determine the Latitude with the Shattuck Solar.

Carefully set off in the solar the south polar distance of the sun at apparent noon, corrected for the refraction at that hour, in the same manner as previously explained.

About fifteen minutes before noon, direct the telescope with the solar attached, toward the lower pole; then move the transit on its vertical axis and the solar on the polar axis until the reflected light of the sun from the fixed mirror is seen to exactly pass through the opening in the base of the frame, with the sides of the solar as nearly vertical as possible. The sun's image will then be in the field of view.

Now bring the upper limb or edge of the sun to the horizontal cross-wire by turning the tangent screw of the telescope axis; then by turning the tangent screw of the polar axis of the solar, cause the sun's image to pass rapidly across the field of view. If the limb of the sun passes

parallel to the horizontal wire, the plane of the solar is in a vertical position; but if not, turn the solar on the polar axis and the transit on its vertical axis, until the plane is vertical as shown by this test.

Keeping the plane of solar vertical, follow the sun's upper limb with the horizontal cross-wire, by turning the tangent screw of the telescope axis, as long as the sun continues to rise.

The sun is at its greatest altitude when it reaches the meridian; therefore at apparent noon, when the sun's image ceases to rise, take the reading of the vertical circle and add to it the sun's semi-diameter as given in the ephemeris, which will give the required latitude. This is illustrated in Fig. 12.

Use of Solar Ephemeris.

The sun's declination at Greenwich mean noon is given in the ephemeris for every day in the year.

Local time at different points on the earth's surface varies at the rate of one hour for every 15 degrees of longitude; the more easterly the place the later the local time.

When it is noon according to "Eastern" (75th meridian), "Central" (90th meridian), "Mountain" (105th meridian), or "Pacific" (120th meridian) time, it is five, six, seven or eight hours, respectively, after noon at Greenwich. Hence, for example, to determine the declination at 9 o'clock, a. m., "Mountain Time," which is four hours (seven hours minus three hours) after mean noon at Greenwich, the given difference for one hour is multiplied by four, which gives the correction to be applied to the given declination, noting carefully the algebraic signs of both the declination and hourly difference as given in the ephemeris.

In using the Shattuck solar attachment the refraction correction is always positive, so that when the sun's

declination is north (+) it is added, and numerically subtracted when the declination is south (—).

This refraction is found under the description of the Burt Solar in a table for various latitudes and periods before and after noon.

The declination of the sun being its distance from the celestial equator, the south polar distance is 90° plus or minus the declination according as the sun is north or south of the equator.

Example:

Required the south polar distance of the sun at 3 p. m., "Mountain Time," May 28, 1902, latitude 40°.

The time is 10 hours (7 + 3) after noon at Greenwich.

Hourly difference	+24.79"
× Number of hours	10.
Total change in declination	+247.9" or + 4' 07.9"
Declination at Greenwich noon	+21° 21' 12.0"
Required declination	+21° 25' 19.9"
Refraction (hour angle 3)	+00' 33.0"
Corrected apparent declination	+21° 25' 52.9"
Declination being north, add	90°
South polar distance	111° 25' 52.9"

To save time, it is advisable, before going into the field, to prepare a table for the day, giving the south polar distances of the sun for every hour suitable for taking observations.

Note.—The methods of figuring declination and refraction are given more fully under the description of the Burt Solar.

The Burt Solar Attachment.

In Fig. 13 we have a graphic illustration of the Burt solar apparatus, the circles shown being intended to repre-

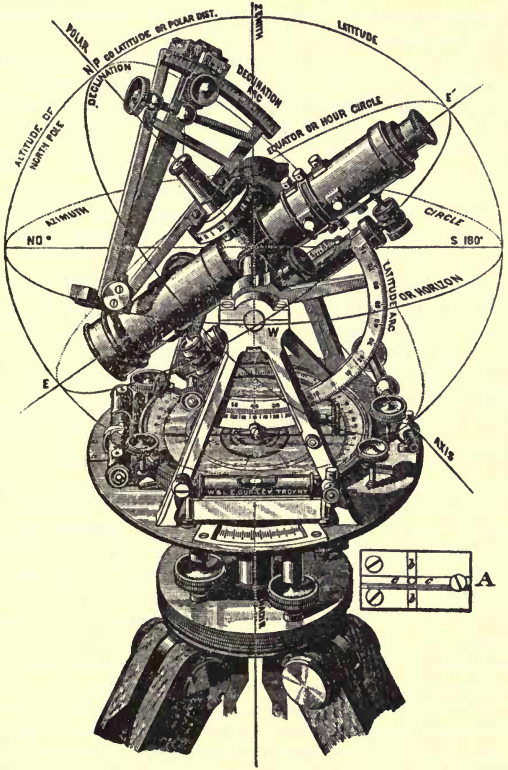

ZENITH
POLAR
N P OR LATITUDE OR POLAR DIST.
DECLINATION
LATITUDE
DECLINATION ARC
ALTITUDE OF NORTH POLE
EQUATOR OR HOUR CIRCLE
E'
AZIMUTH
CIRCLE
NO °
S 180°
ALTITUDE OR HORIZON
W
E
NADIR
A

Fig. 13. Fig. 14.

sent those supposed to be drawn upon the concave surface of the heavens.

When the telescope is set horizontal by its spirit-level, the hour-circle will be in the plane of the horizon, the polar axis will point to the zenith, and the zeros of the vertical arc and its vernier will coincide. Now if we incline the telescope, directed north as shown in the cut, the polar axis will descend from the direction of the zenith. The angle through which it moves, being laid off on the vertical arc, will be the co-latitude of the place where the instrument is supposed to be used, the latitude itself being found by subtracting this number from 90°.

When, however, the sun passes above or below the equator, his declination, or angular distance from it, as given in the ephemeris, can be set off upon the arc, and his image brought into position as before.

In order to do this, however, it is necessary not only that the latitude and declination be correctly set off upon their respective arcs, but also that the instrument be moved in azimuth until the polar axis points to the pole of the heavens, or, in other words, is placed in the plane of the meridian; and thus the position of the sun's image will indicate not only the latitude of the place, the declination of the sun for the given hour and the apparent time, but will also determine the meridian, or true north and south line passing through the place where the observation is made.

The interval between two equatorial lines, cc, as well as between the hour lines, bb, (Fig. 14), is just sufficient to include the circular image of the sun, as formed by the solar lens on the opposite side of the revolving arm.

Allowance for declination: Let us now suppose the observation made when the sun has passed the equinoctial point, and when his position is affected by declination.

By referring to the ephemeris, and setting off on the

arc his declination for the given day and hour, we are still able to determine his position with the same certainty as if he remained on the equator.

When the sun's declination is south, that is, from the 22nd of September to the 20th of March, in each year, the arc is turned downward, or towards the plates of the transit, while during the remainder of the year the arc is turned from the plates.

When the solar attachment is accurately adjusted and its plates made perfectly horizontal, the latitude of the place (co-latitude from horizontal) and the declination of the sun for the given day and hour being also set off on their respective arcs, and the instrument set approximately north by the magnetic needle, the image of the sun cannot be brought between the equatorial lines until the polar axis is placed in the plane of the meridian of the place, or in a position parallel with the axis of the earth.

The slightest deviation from this position will cause the image to pass above or below the lines, and thus discover the error.

To Run Lines with the Burt Solar Attachment.

Having set off the latitude of the place (co-latitude from horizontal) on the vertical arc, and the declination for the given day and hour as computed from the tables in the solar ephemeris, the instrument being also carefully levelled by the telescope bubble, set the horizontal limb at zero and clamp the plates, loosen the lower screw so that the transit moves easily upon its lower socket, set the instrument approximately north and south, with the object-glass end of the telescope towards the north, turn the proper solar lens to the sun, and with one hand on the plates and the other on the revolving arm move them from side to side until the sun's image is brought between the equatorial lines on the silver plate.

The lower clamp of the instrument should now be

fastened, and any further lateral movement be made by the tangent screw of the levelling head. The necessary allowance being made for refraction, the telescope will be in the true meridian from which any lines desired may be deflected.

The declination of the sun given in the Ephemeris, or Nautical Almanac, from year to year, is calculated for apparent noon at Greenwich, England.

To determine it for any other hour at a place in the United States, reference must be had, not only to the difference of time arising from the difference of longitude, but also to the change of declination during that time.

The longitude of the place, and therefore its difference in time, if not given directly in the ephemeris, can be ascertained very nearly by reference to that of other places given which are situated on, or very nearly on, the same meridian.

It is the practice of surveyors in states east of the Mississippi to allow a difference of six hours for the difference in longitude, calling the declination given in the ephemeris for 12 m. that of 6 a. m. at the place of observation.

Beyond the meridian of Santa Fé, the allowance would be about seven hours; and in California, Oregon and Washington about eight hours.

Having thus the difference in time, we very readily obtain the declination for a certain hour in the morning, which would be earlier or later as the longitude was greater or less, and the same as that of apparent noon at Greenwich on the given day. Thus, suppose the observation to be made at a place five hours later than Greenwich, then the declination given in the ephemeris for the given day at noon, affected by the refraction, would be the declination at the place of observation for 7 a. m.; this gives us the starting point.

To obtain the declination for the other hours of the day, take from the ephemeris the declination for apparent noon for the given day, and, as the declination is increasing or decreasing, add to, or subtract from, the declination of the first hour the difference for one hour as given in the ephemeris, which will give, when affected by the refraction, the declination for the succeeding hour; and proceed thus in making a table of declination for every hour of the day.

The table of refractions is calculated for latitudes between 15° and 60° at intervals of 2½°, that being as near as is required.

The declination ranges from 0° to 20° both north and south, the + declinations being north and the — south, and is given for every 5°, that being sufficiently near for all practical purposes. The hour angle in the first column indicates the distance of the sun from the meridian in hours, the refraction given for 0 hours being that which affects the observed declination of the sun when on the meridian, commonly known as the meridianal refraction; the refraction for the hour just before or after noon is so nearly that of the meridian that it may be called and allowed as the same.

When the table is used it must be borne in mind that when the declination is north, or + in the table, the refraction is to be added; when the declination is south, or — the refraction must be subtracted. It will be noted that the refraction in south declination increases very rapidly as the sun nears the horizon, showing that observations should not be taken with sun when south of the equator, less than one hour from the horizon.

To Compute the Declination.

Suppose it was required to obtain the declination for the different hours of April 16, 1895, at Troy, New York.

The longitude in time is four hours, fifty-four minutes

and forty seconds, or practically five hours; so that the declination given in the ephemeris for apparent noon of that day at Greenwich would be that of 7 a. m. at Troy.

Declination at Greenwich at noon of April 16, 1895.

N. 10° 7′ 56″.5

			Troy.
N. 10° 7′ 56″.5+Refr. add hr.dif.	5 hrs. 1′ 58″.2	= 10° 9′ 54″ = Dec.	7 a. m.
10° 8′ 49″.7+Refr. 53″.2	4 hrs. 1′ 11″	= 10° 10′ 00″ = Dec.	8 a. m.
10° 9′ 42″.9+Refr. 53″.2	3 hrs. 52″	= 10° 10′ 34″ = Dec.	9 a. m.
10° 10′ 36″.1+Refr. 53″.2	2 hrs. 39″	= 10° 11′ 15″ = Dec.	10 a. m.
10° 11′ 29″.3+Refr. 53″.2	1 hr. 36″	= 10° 12′ 05″ = Dec.	11 a. m.
10° 12′ 22″.5+Refr. 53″.2	0 hrs. 36″	= 10° 12′ 58″ = Dec.	12 m.
10° 13′ 15″.7+Refr. 53″.2	1 hr. 36″	= 10° 13′ 51″ = Dec.	1 p. m.
10° 14′ 08″.9+Refr. 53″.2	2 hrs. 39″	= 10° 14′ 47″ = Dec.	2 p. m.
10° 15′ 02″.1+Refr. 53″.2	3 hrs. 52″	= 10° 15′ 54″ = Dec.	3 p. m.
10° 15′ 55″.3+Refr. 53″.2	4 hrs. 1′ 11″	= 10° 17′ 06″ = Dec.	4 p. m.
10° 16′ 48″.5+Refr.	5 hrs. 1′ 58″	= 10° 18′ 46″ = Dec.	5 p. m.

Again, suppose it was desired to obtain the corrected declination for the different hours of October 16, 1895, at Troy, New York.

The difference in time being nearly five hours, and the

declination at Greenwich, noon, 8° 53′ 53″.6, that declination affected by the refraction would give the true declination for 7 a. m. at Troy; the latitude being nearly 42° 30′. The declination being now south, the refraction is to be subtracted, but the hourly difference is to be added because the declination is increasing, as in the first example; thus:

		Troy.
S. 8° 53′ 53″.6—Refr. 5 hrs. 9′ 24″=	8° 44′ 30″= Dec.	7 a. m.
add hr.dif.55″.3		
8° 54′ 48″.9—Refr. 4 hrs. 2′ 49″=	8° 52′ 00″= Dec.	8 a. m.
55″.3		
8° 55′ 44″.2—Refr. 3 hrs. 1′ 49″=	8° 53′ 55″= Dec.	9 a. m.
55″.3		
8° 56′ 39″.5—Refr. 2 hrs. 1′ 26″=	8° 55′ 13″= Dec.	10 a. m.
55″.3		
8° 57′ 34″.8—Refr. 1 hr. 1′ 14″=	8° 56′ 21″= Dec.	11 a. m.
55″.3		
8° 58′ 30″.1—Refr. 0 hrs. 1′ 14″=	8° 57′ 16″= Dec.	12 m.
55″.3		
8° 59′ 25″.4—Refr. 1 hr. 1′ 14″=	8° 58′ 11″= Dec.	1 p. m.
55″.3		
9° 00′ 20″.7—Refr. 2 hrs. 1′ 26″=	8° 58′ 55″= Dec.	2 p. m.
55″.3		
9° 01′ 16″.0—Refr. 3 hrs. 1′ 49″=	8° 58′ 27″= Dec.	3 p. m.
56″.3		
9° 02′ 11″.3—Refr. 4 hrs. 2′ 49″=	8° 59′ 22″= Dec.	4 p. m.
55″.3		
9° 63′ 06″.6—Refr. 5 hrs. 9′ 24″=	8° 53′ 43″= Dec.	5 p. m.

These calculations should of course be made before the surveyor begins work in the field.

A Table of Mean Refractions in Declination to Be Used With the Shattuck and Burt Solar Attachments. Apply to the Declination as Found in the Ephemeris.

HOUR ANGLE	DECLINATIONS. For Latitude 15°.								
	+20°	+15°	+10°	+5°	0°	-5°	-10°	-15°	-20°
0 h.	-05″	0″	+05″	10″	15″	21″	27″	33″	40″
2 h.	-03″	+02″	07″	12″	18″	23″	29″	36″	43″
3 h.	+01″	05″	11″	16″	22″	28″	34″	41″	49″
4 h.	08″	12″	19″	24″	30″	37″	44″	53″	1′04″
5 h.	29″	34″	41″	49″	59″	1′10″	1′24″	1′43″	2′08″
	For Latitude 17° 30′.								
0 h.	-02″	+02″	08″	13″	18″	24″	30″	36″	44″
2 h.	0″	05″	10″	15″	21″	27″	33″	40″	48″
3 h.	+02″	10″	15″	21″	27″	33″	40″	48″	57″
4 h.	13″	18″	23″	29″	35″	43″	51″	1′01″	1′13″
5 h.	34″	41″	49″	58″	1′10″	1′23″	1′41″	2′06″	2′42″
	For Latitude 20°.								
0 h.	0″	05″	10″	15″	21″	27″	33″	40″	48″
2 h.	03″	07″	13″	18″	24″	30″	36″	44″	52″
3 h.	06″	13″	18″	24″	30″	36″	44″	52″	1′02″
4 h.	17″	22″	28″	35″	42″	50″	1′00″	1′11″	1′26″
5 h.	39″	47″	57″	1′07″	1′20″	1′37″	2′00″	2′32″	3′25″
	For Latitude 22° 30′.								
0 h.	02″	08″	13″	18″	24″	30″	36″	44″	52″
2 h.	06″	11″	15″	21″	27″	33″	40″	48″	57″
3 h.	11″	15″	21″	27″	33″	40″	48″	57″	1′08″
4 h.	20″	26″	32″	39″	46″	56″	1′07″	1′19″	1′37″
5 h.	45″	53″	1′03″	1′16″	1′31″	1′52″	2′21″	3′07″	4′28″
	For Latitude 25°.								
0 h.	05″	10″	15″	21″	27″	33″	40″	48″	57″
2 h.	08″	14″	19″	25″	31″	38″	46″	54″	1′05″
3 h.	12″	18″	24″	30″	37″	44″	53″	1′04″	1′18″
4 h.	23″	29″	35″	45″	53″	1′03″	1′16″	1′31″	1′52″
5 h.	49″	59″	1′10″	1′24″	1′52″	2′07″	2′44″	3′46″	5′43″
	For Latitude 27° 30′.								
0 h.	08″	13″	18″	24″	30″	36″	44″	52″	1′02″
2 h.	11″	16″	22″	28″	34″	41″	49″	1′00″	1′10″
3 h.	17″	22″	28″	35″	42″	50″	1′00″	1′11″	1′26″
4 h.	28″	35″	42″	50″	1′00″	1′11″	1′26″	1′43″	2′09″
5 h.	54″	1′05″	1′18″	1′34″	1′54″	2′24″	3′11″	4′38″	8′15″

DECLINATIONS.

HOUR ANGLE

For Latitude 30°.

	+20°	+15°	+10°	+5°	0°	-5°	-10°	-15°	-20°
0 h.	10″	15″	21″	27″	33″	40″	48″	57″	1′08″
2 h.	14″	19″	25″	31″	38″	46″	54″	1′05″	1′18″
3 h.	20″	26″	32″	39″	47″	55″	1′06″	1′19″	1′36″
4 h.	32″	39″	46″	52″	1′06″	1′19″	1′35″	1′57″	2′29″
5 h.	1′00″	1′10″	1′24″	1′52″	2′07″	2′44″	3′46″	5′43″	13′06″

For Latitude 32° 30′.

0 h.	13″	18″	24″	30″	36″	44″	52″	1′02″	1′14″
2 h.	17″	22″	28″	35″	42″	50″	1′00″	1′11″	1′26″
3 h.	23″	29″	35″	43″	51″	1′01″	1′13″	1′28″	1′47″
4 h.	35″	43″	51″	1′01″	1′13″	1′27″	1′46″	2′13″	2′54″
5 h.	1′03″	1′15″	1′31″	1′53″	2′20″	3′05″	4′25″	7′36″	

For Latitude 35°.

0 h.	15″	21″	27″	33″	40″	48″	57″	1′08″	1′21″
2 h.	20″	25″	32″	38″	46″	55″	1′05″	1′18″	1′35″
3 h.	26″	33″	39″	47″	56″	1′07″	1′21″	1′38″	2′00″
4 h.	39″	47″	56″	1′07″	1′20″	1′36″	1′59″	2′32″	3′25″
5 h.	1′07″	1′20″	1′38″	2′00″	2′34″	3′29″	5′14″	10′16″	

For Latitude 37° 30′.

0 h.	18″	24″	30″	36″	44″	52″	1′02″	1′14″	1′29″
2 h.	22″	28″	35″	42″	50″	1′00″	1′12″	1′26″	1′45″
3 h.	29″	36″	43″	52″	1′02″	1′14″	1′29″	1′49″	2′16″
4 h.	43″	51″	1′01″	1′13″	1′27″	1′49″	2′14″	2′54″	4′05″
5 h.	1′11″	1′26″	1′54″	2′10″	2′49″	3′55″	6′15″	14′58″	

For Latitude 40°.

0 h.	21″	27″	33″	40″	48″	57″	1′08″	1′21″	1′39″
2 h.	25″	32″	39″	46″	52″	1′06″	1′19″	1′35″	1′57″
3 h.	33″	40″	48″	57″	1′08″	1′21″	1′38″	2′02″	2′36″
4 h.	47″	55″	1′06″	1′19″	1′36″	1′58″	2′30″	3′21″	4′59″
5 h.	1′15″	1′31″	1′51″	2′20″	3′05″	4′25″	7′34″	25′18″	

For Latitude 42° 30′.

0 h.	24″	30″	36″	44″	52″	1′02″	1′14″	1′29″	1′49″
2 h.	28″	35″	39″	50″	1′00″	1′12″	1′26″	1′45″	2′11″
3 h.	36″	43″	52″	1′02″	1′13″	1′29″	1′49″	2′17″	2′59″
4 h.	50″	1′00″	1′11″	1′26″	1′44″	2′10″	2′49″	3′55″	6′16″
5 h.	1′16″	1′36″	1′58″	2′30″	3′22″	5′00″	9′24″		

For Latitude 45°.

0 h.	27″	33″	40″	48″	57″	1′08″	1′21″	1′39″	2′02″
2 h.	32″	39″	46″	52″	1′06″	1′19″	1′35″	1′57″	2′29″
3 h.	40″	47″	56″	1′07″	1′21″	1′38″	2′00″	2′34″	3′29″
4 h.	54″	1′04″	1′16″	1′33″	1′54″	2′24″	3′11″	4′38″	8′15″
5 h.	1′23″	1′41″	2′05″	2′41″	3′40″	5′40″	12′02″		

HOUR ANGLE

DECLINATIONS.

For Latitude 47° 30'.

	+20°	+15°	+10°	+5°	0°	-5°	-10°	-15°	-20°
0 h.	30″	36″	44″	52″	1′02″	1′14″	1′29″	1′49″	2′18″
2 h.	35″	42″	50″	1′00″	1′12″	1′26″	1′45″	2′01″	2′51″
3 h.	43″	51″	1′01″	1′13″	1′28″	1′47″	2′15″	2′56″	4′08″
4 h.	56″	1′09″	1′23″	1′40″	2′05″	2′40″	3′39″	5′37″	11′18″
5 h.	1′27″	1′46″	2′12″	2′52″	4′01″	6′30″	16′19″		

For Latitude 50°.

0 h.	33″	40″	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″
2 h.	38″	46″	55″	1′06″	1′18″	1′35″	1′57″	2′28″	3′19″
3 h.	47″	56″	1′06″	1′19″	1′36″	2′29″	2′31″	3′23″	5′02″
4 h.	1′02″	1′14″	1′29″	1′48″	2′16″	2′58″	4′18″	6′59″	19′47″
5 h.	1′30″	1′51″	2′19″	3′04″	4′22″	7′28″	24′10″		

For Latitude 52° 30'.

0 h.	35″	44″	52″	1′02″	1′14″	1′29″	1′49″	2′18″	3′05″
2 h.	43″	50″	59″	1′11″	1′26″	1′42″	2′23″	2′49″	3′55″
3 h.	50″	1′00″	1′11″	1′26″	1′45″	2′11″	2′51″	2′58″	6′22″
4 h.	1′05″	1′18″	1′35″	2′10″	2′28″	3′19″	4′53″	8′42″	
5 h.	1′34″	1′56″	2′27″	3′16″	4′47″	8′52″			

For Latitude 55°.

0 h.	40″	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″
2 h.	46″	55″	1′05″	1′18″	1′34″	1′56″	2′30″	3′15″	4′47″
3 h.	55″	1′06″	1′19″	1′35″	1′58″	2′30″	3′21″	4′58″	9′19″
4 h.	1′10″	1′23″	1′42″	2′06″	2′43″	3′44″	5′49″	12′41″	
5 h.	1′37″	2′01″	2′34″	3′28″	5′15″	10′18″			

For Latitude 57° 30'.

0 h.	44″	52″	1′02″	1′14″	1′29″	1′49″	2′18″	3′05″	4′37″
2 h.	50″	59″	1′11″	1′25″	1′43″	2′09″	2′47″	3′51″	6′04″
3 h.	58″	1′10″	1′24″	1′42″	2′07″	2′43″	3′45″	5′50″	12′47″
4 h.	1′11″	1′25″	1′43″	2′10″	2′50″	3′55″	6′14″	14′49″	
5 h.	1′41″	2′06″	2′42″	3′42″	5′46″	12′26″			

For Latitude 60°.

0 h.	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″	5′23″
2 h.	54″	1′04″	1′17″	1′33″	1′54″	2′24″	3′12″	4′38″	8′15″
3 h.	1′03″	1′15″	1′30″	1′51″	2′20″	3′04″	4′24″	7′31″	24′44″
4 h.	1′18″	1′34″	1′56″	2′28″	3′18″	4′50″	8′53″		
5 h.	1′45″	2′11″	2′50″	3′57″	5′21″	15′32″			

To Find the Latitude With the Burt Solar Attachment.

First, level the instrument very carefully, using, as before, the level of the telescope until the bubble will remain in the middle during a complete revolution of the instrument, the tangent movement of the telescope being used in connection with the leveling-screws of the parallel plates, and the axis of the telescope being firmly clamped.

Next, clamp the vertical arc, so that its zero and the zero of its vernier coincide as near as may be, and then bring them into exact line by the tangent screw of the vernier.

Then, having the declination of the sun for 12 o'clock of the given day as affected by the meridional refraction carefully set off upon the declination arc, note also the equation of time; and fifteen or twenty minutes before noon, the telescope being directed to the north and the object-glass end lowered until, by moving the instrument upon its spindle and the declination arc from side to side, the sun's image is brought nearly into position between the equatorial lines. Now bring the declination arc directly in line with the telescope, clamp the axis, and with the tangent screw of the telescope axis bring the image precisely between the lines and keep it there with the tangent screw, raising it as long as it runs below the lower equatorial line, or, in other words, as long as the sun continues to rise in the heavens.

When the sun reaches the meridian the image will remain stationary in altitude for an instant, and will then begin to rise on the plate.

The moment the image ceases to run below is, of course, apparent noon, when the index of the hour arc should indicate XII., and the latitude be determined by the reading of the vertical arc.

The angle through which the polar axis has moved in the operation just described is measured from the zenith instead of from the horizon so that the angle read on the

vertical limb is the complement of the latitude or co-latitude.

To Adjust the Burt Solar Attachment.

The declination arm is first detached by removing the clamp and tangent screws and the center with its small screws, by which the arm is attached to the arc.

The adjuster, which is a short bar furnished with every instrument, is then substituted for the declination arm, the center screwed into its place at one end, and the clamp-screw into the other, being inserted through the hole left by the removal of the tangent screw, thus securing the adjuster firmly to the arc.

The declination arm is then placed on the adjuster, one end is turned to the sun, and brought into such a position that the image of the sun is brought precisely between the equatorial lines on the opposite plate.

Carefully turn the arm over, until it rests upon the adjuster by the opposite faces of the rectangular blocks, and again observe the sun's image. If it remains between the lines as before, the arm is in adjustment. If not, loosen the three small screws which hold it to the arm, and move the silver plate under their heads until one-half the error in the position of the sun's image is removed.

Bring the image again between the lines, and repeat the operation as above on both ends of the arm, until the image will remain between the lines of the plate in both positions of the arm, when it will be in proper adjustment, and the arm may be replaced in its former position on the attachment. This adjustment is very rarely needed in these instruments, the lenses being cemented in their cells and the plates securely fastened.

To adjust the Vernier of the Declination Arc: Set the vernier at zero, and then raise or lower the telescope until the sun's image appears exactly between the equatorial lines .

Having the telescope axis clamped, carefully revolve the arm until the image appears on the other plate. If precisely between the lines, the adjustment is complete; if not, move the declination arm by its tangent screw until the image will come precisely between the lines on the two opposite plates; clamp the arm and remove the index error by loosening two screws that fasten the vernier; place the zeros of the vernier and limb in exact coincidence, tighten the screws, and the adjustment is complete.

To Adjust the Polar Axis: First, level the instrument carefully by the long level of the telescope, using in the operation the tangent movement of the telescope axis in connection with the leveling-screws of the parallel plates, until the bubble will appear in the middle during a complete revolution of the instrument upon its axis.

Place the solar apparatus upon the axis and see that it moves easily around it; bring the declination arm in the same vertical plane with the telescope; place the adjusting level upon the top of the rectangular blocks, and bring the bubble into the middle by the tangent screw of the declination arc.

Then turn the arc half way around, bringing it again parallel with telescope, and note the position of the level. If in the middle, the polar axis is vertical in that direction; if not in the middle, correct one-half of the error by the capstan-head adjusting screws under the base of the polar axis, moving each screw of the pair the same amount, but in an opposite direction. Bring the level to the middle again by the tangent screw of the declination arc, and repeat the operation as before, until the bubble will remain in the middle when the adjusting-level is reversed.

Pursue the same course in adjusting the arc in the second position, or over the telescope axis, and when completed the level will remain in the middle during an entire revolution of the arc, showing that the polar axis is at right angles with the level under the telescope, or truly vertical.

Care should be taken that the level under the telescope is kept in the middle, and the capstan-screws brought to a firm bearing.

The adjusting-level in the operation just described is supposed to be itself in adjustment; but if not, it can be easily corrected by the screw shown at one end, when reversed upon a plane surface, exactly as a mason's level is adjusted.

As this is by far the most delicate and important adjustment of the solar attachment, it should be made with the greatest care, the bubble kept perfectly in the middle and frequently inspected in the course of the adjustment.

To Adjust the Hour-Arc: Whenever the instrument is set in the meridian, as will be hereafter described, the index of the hour-arc should read apparent time. If not, loosen the two flat head screws on the top of the hour-circle, and with the hand turn the circle around until it does, fasten the screws again, and the adjustment will be complete.

To obtain mean time, the correction of the equation for the given day, as found in the Nautical Almanac, should always be applied.

Berger and Saegmuller Solars.

The principle of these two solar attachments is the same. (Fig. 15 A and B.). The declination of the sun for the place and hour required is figured as previously shown. This declination is regarded as plus or minus as it is north or south and added algebraically to the refraction which is always plus. The refraction is found from the table previously given for the Burt and Shattuck solars or for each day and hour in the ephemeris issued for the Saegmuller solar. The declination corrected for refraction being determined, the instrument provided with the solar (see Fig. 15 A and B) is carefully levelled and the line of collimation of the solar and main telescope made parallel

by sighting at some distant object. The declination is now set off on the vertical arc or circle of the transit by depressing the telescope when the declination is north, and raising the telescope when the declination is south. The solar telescope is then levelled by means of its attached bubble with the main telescope still clamped. The co-latitude is then set off on the vertical circle of the transit, and the solar telescope directed towards the sun, which is bisected exactly as in the case of the direct observation.

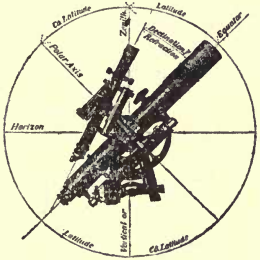


Fig. 15 A.

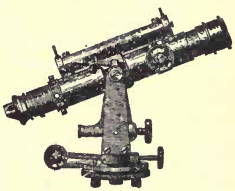


Fig. 15 B.

This is done by turning the solar on its vertical axis and by means of the lower motion of the transit. If the horizontal plates have been previously clamped at 0°, with the lower motion unclamped, as soon as the sun is bisected by the solar telescope, the main telescope is necessarily pointing due south. If now the lower motion is clamped and the upper motion free, the direction of the main telescope as read on the horizontal plates will give the correct bearing.

By an ingenious attachment called an equatorial adaptor, the auxiliary telescope made by C. L. Berger and used in sighting down steep shafts may be used exactly as the Saegmuller solar.

CHAPTER III.

Traversing.

The bearing of the initial line of the survey being known, there are two ways of carrying it forward in the course of the work. When it is necessary that the correct bearing should be known at all times during the field work, as for example in retracing old lines, it is best to retain the bearing always on the upper plate of the transit, back-sighting with the upper plate, giving the last forward course and then turning the upper plate in any new direction required. This method may be used at all times and simplifies the note taking somewhat, and adds to subsequent clearness. The disadvantages are that the upper plate may move somewhat in transportation between stations, and the vernier must be carefully examined each time a back-sight is made. Then, too, it may be inconvenient and is usually unnecessary to figure out the direct solar observation in the field, in which case the entire survey may be completed with either an assumed bearing to commence with, or else by angles, without the use of any bearing whatever. When angles alone are used the angle of the initial line surveyed with the line whose bearing is determined by direct solar observation is read and when these are identical, as is usually the case, the first line is simply measured to the second station. At the second station the upper plate is set at 0°, the first station bisected by the use of the lower plate and the angle to the next station read as from left to right or the hands of a watch, and noted. When side shots are made, it is well to make horizontal parallel lines above and below the notes taken, so that the line or lines of notes will not be confused with

the notes of the main continuous traverse. By this method of carrying forward a survey all errors of instrumental adjustment are eliminated except those entering in the height of standards. Another method of traversing commonly used is to back-sight with the upper plate of the transit at 0°, then invert the telescope and turn to the right or left and read the angle turned. While this is probably the method usually employed, it involves a doubling of any errors in adjustment of the transit and a possible error in setting down each time the fact that the instrument was turned right or left. On the other hand, the results are more easily reduced to courses than in the method given before, which is always used by the writer.

It is well to read the compass at each station as a precaution against large errors.

Measuring.

At the same time that the bearings are being carried forward with the instrument, measurements are being taken. These measurements as a rule are to determine the distance traversed, but are also at times for the purpose of laying out a certain necessary distance. Practically all measurements now made in mineral land surveying are made with long steel tapes, 300 to 700 feet in length, graduated every five feet, with each end of the tape graduated to five feet. The method of using long tapes is as follows: The chainman holds the zero of the tape at the station to which the measurement is to be made, and the transit man pulls the tape, preferably holding it taut by a pair of parallel pliers, provided with a clamp, just opposite the trunnion of the telescope. The distance is then measured to the nearest five-foot mark with a pocket tape from the point marked by the clamped parallel pliers. When the nearest five-foot mark is beyond the transit man, it saves subtracting the tenths, to which measurements are usually taken, to place the five-foot mark on the pocket tape over

the five-foot mark on the long tape, and then read as from the five-foot point ahead of the instrument. Another method for reading the tape is for the transit man to hold the five-foot mark just beyond the distance measured to the transit, the chainman then holds the tape tightly wherever it happens to come at the forward point. He then reads on the finer graduations the distance from the zero point back to the station and this is subtracted from the distance read opposite the transit. This method is, however, rarely used, as it requires a reliable chainman, and involves possible mistakes is subtracting. It also requires finer graduations on the zero end of the tape.

In traversing, the tape may be wound up after each measurement or may be dragged over the ground. The writer prefers the second method, as it saves time. There is, however, greater danger of breaking the tape. Should the tape break it may be temporarily mended by using Alexander's Little Giant Tape Splices, or the surveyor may even carry a piece of solder with a few brass or copper sleeves which he solders on with a candle. As a rule, however, he proceeds with the longest portion of the broken tape. As the tape breaks most frequently near the zero end, and the chainman has then no handle, it is well to carry an extra pair of parallel pliers for such an emergency.

There are many cases where stadia measurements in mineral land surveying could be used with advantage, but they are rarely employed. In the first place, they are strictly forbidden by the land office regulations in all government work. In preliminary work, such as in laying out location surveys, there is great difficulty in persuading the claimant that he is getting anything at all accurate, when the surveyor is compelled to admit that it can not be used in surveying for patent.

The choosing of proper stations is a very important part of the chainman's duty. A careful chainman can, by

good judgment, save much valuable time in selecting stations which in the first place offer good fore-sights, and in the second place are suitable for set-ups. In the mountains of the West there is frequently little or no choice in the placing of stations, and the best are often none too good. Stations are usually marked by stakes picked up near the spot. In case it is desired to preserve the traverse stakes, they had best be made of hard wood and carried in sufficient quantity by the party. Opinions differ as to the height of stations. Many, among others the writer, prefer a short stake, not showing as a rule over a foot above the surface of the ground. Others prefer a long stake. With the short stake a plumb line will as a rule have to be used for both the fore and back-sights, but the station is more stable, and is likely to remain in place. With the long stake the use of the plumb may be avoided, as the stake may be seen from the instrument, and this will often save time, but the stakes are very liable to derangement after the lapse of a few days. In many cases large nails may be used for stations, in which case they are simply driven in the ground. They are especially useful in winter when the ground is frozen.

The exact station point on the stake is marked by a nail or tack and, when possible, the measurement is made directly to the point, and both cross wires of the telescope, their intersection, placed on the nail head. In case the nail can not be seen, the instrument is sighted to a plumb line, the height to which the zero of the tape is held being taken by the horizontal cross wire. In windy weather long plumb bobs filled with mercury give the best results.

When the surveyor has a clear fore-sight for a longer distance than the tape will reach, and the country is not too rough, he may set his fore-sight stakes ahead at a distance apart approximately equal to the stretch of his tape. He may then set up at every other stake, omitting

those in between, and make a measurement each way fore and back from each set-up. This will often save considerable time.

The vertical angles for most work need to be read only to the nearest fifteen minutes; that is, they should be within 7½ minutes of the correct, and may be read without the use of the verniers on most transits. As a rule in western mineral surveying the horizontal distances must be figured in the field. The best method of figuring is probably by the use of the pocket traverse table, and the Roe traverse table is the only suitable one known to the writer.

The method of using is as follows:

Vertical angle.	Distance.	Horizontal dis. (Lat.)
23°	261.5 = 260.	239.3
	1.5	1.3
	261.5	240.6

Many times a certain definite distance must be laid out with the tape on a hill side, as for example the end of a lode claim and also in setting corners from the center line. We will take the example where we have to find that to complete the 1,500 feet of a lode claim we have 294.5 feet yet to go. We find the angle of slope is 15° and this apparently continues for the distance required. From the traverse table we find that the nearest horizontal (latitude) to 294.5 given in the column for 15° is 289.8, which equals 300 feet on the slope. This leaves a horizontal distance over of 4.7 which in turn equals 4.9 on the slope. The distance to be laid off is therefore 304.9 feet on the slope.

Example:	Ver. Angle.	Horizontal.	Slope.
	15°	289.8	= 300
		4.7	= 4.9
		294.5	= 304.9

In case of end lines 75, 150 and 300 feet respectively, from the center line, natural secants may be used for laying off distances. For the distance 300 the multiplication may be easily made, but for 75 and 150 feet the surveyor had best prepare a table for each fifteen minutes and paste in his note book. A complete table of natural secants prepared as a traverse table would save much time to the mineral surveyor.*

To return to laying out distances, it will often be found, especially by one who is not good at estimating distances, that the trial angle of slope is too small or too great, as the case may be, and the horizontal wire of the instrument either hits the ground or comes too high above the station. In that case the only thing to do is to try a new angle until everything corresponds.

The final distance to be measured is marked on the tape by the parallel pliers and the instrument sighted to the zero of the tape held at the proper height on a stake or by plumb bob.

The surveyor will frequently meet obstacles which require offsets, which subject is, as a rule, well handled in the standard books on surveying. The usual offset is at right angles far enough to avoid the obstacle. A convenient offset is to turn off say 60° to the right, measure any suitable distance, then run the same distance with 60° turned to the left. In this way the distance required is exactly equal to the distance measured on the offset, as we are dealing with an equilateral triangle. (See Fig. 16.)

Sometimes a long traverse has to be made to get around an obstacle, and sometimes the measurement has to be made by triangulation either to the point which it is desired to reach or to some point near. Triangulation methods are of course simple, and are exhaustively treated in

*An incomplete table of natural secants is to be found in Hodgman's Surveyors' Tables.

text books. Traverses, that is, measured traverses to find a missing course, are not, as a rule, so well handled in the text books, and it is sometimes necessary to do all the figuring in the field. In figuring a traverse, the first thing necessary to do is to get the traverse into a record of courses and distances. When the true bearing is carried throughout the survey nothing has to be done but to put

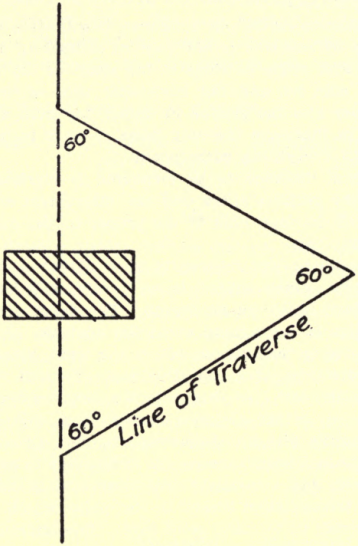


Fig. 16.

down the bearings and the horizontal measurements, and figure the latitudes and departures. When assumed bear-

ings have been used, they must be corrected. In case the inverting right or left method has been used from the initial bearing, the succeeding courses may be easily figured. In case the instrument is read as though turned from left to right, that is, with the hands of a watch, the following rule simplifies the calculation of bearings.

Rule: Take angle right from back-sight. If less than 180°, add 180°; if greater than 180°, subtract 180° from it. Add results to former course from north, or azimuth. If required, subtract 360°. The result is the azimuth from north.

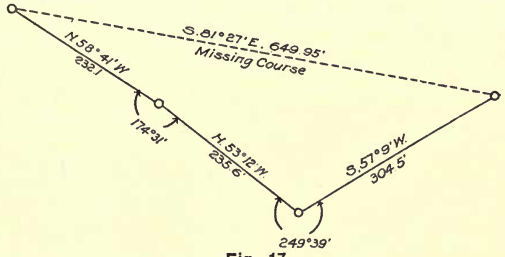


Fig. 17.

Example: (Fig. 17.)

S. 57° 9' W.
180°
237° 9'
69° 39'
306° 48' = N. 53° 12' W.

249° 39'
180°
69° 39'
174° 31'
180°
354° 31'

354° 31'
661° 19'
360°
301° 19' = N. 58° 41' W.

Azimuth =

Azimuth first course =

Azimuth second course =

The courses and horizontal distances at hand, the latitudes and departures are figured, preferably with a traverse table. Among the many traverse tables, Gurden's is the most rapid. In using the Gurden's tables to facilitate picking out the figures, a triangle preferably a transparent one, or even a card may be marked and so spaced that one mark being placed under the latitude figure, the other mark falls of itself under the figure for the departure.

An example of a short traverse is given below, with the missing course calculated and many similar cases will be given later. There are also given examples of latitudes and departures figured with the Gurden's table.

Neat and systematic work may be done by the use of printed blanks, each of which is afterwards filed away, as will be described later.

		Cos. Latitude.	Sin. Departure.
57° 9'			
300		162.73	252.03
4.5		2.44	3.78
		165.17	255.81
53° 12'			
230		137.77	184.16
5.6		3.35	4.48
		141.12	188.64
58° 41'			
230		119.54	196.49
2.1		1.09	1.79
		120.63	198.28

Station.	Course.	Distance.	N. Lat.	S. Lat.	E. Dep.	W. Dep.
——	S. 57° 9' W.	304.5	.....	165.17	.....	255.81
——	N. 53° 12' W.	235.6	141.12	.....	.....	188.64
——	N. 58° 41' W.	232.1	120.63	.....	.....	198.28
			261.75			642.73
			165.17			
			96.58			

log 96.58 = 1.984887
log 642.73 = 2.808028

9.176859 = log cot 81° 27′

log 642.73 = 2.808028
log sin 81° 27′ = 9.995146

2.812882 = log 649.95

Missing course = S. 81° 27′ E. 649.95

Note:—It is well to remember to take the log of the larger number, whether latitude or departure, and divide it by the larger log, whether sine or cosine of the angle found.

CHAPTER IV.

Lode Location.

About the simplest survey that the western surveyor is called on to make is that of a lode location. It is, however, somewhat complicated by the fact that as a rule he is assisted by the claimant himself in the work and thus often lacks an efficient assistant, with the result that the character of the results suffers.

Usually the survey is begun at the discovery point, which may be a shaft, cut, adit, or even a point in the tunnel or other underground workings. We will begin with the survey of a straight claim as in Fig. 18. (See also page of note book) The first set-up is just

Fig. 18.

thirty feet from the center of the discovery shaft. After the direction of the center line has been determined, and this may often be done in unimportant work with the magnetic needle, a measurement is made as before explained under measurements, to station No. 2. It will save the transit man a set-up if a measurement is taken at the same time to No. 5. This will, however in a rough country, give the chainman more work. From station No. 2 the line is extended through No. 3 to No. 4, at which point the claimant having desired to end his claim, a right angle is turned off, and the stakes set, we will say, seventy-five feet on each side of the center line. These stakes, the best ob-

GOOD SAMARITAN LODE, RUSSELL M. DIST.

Monday, May 29th, 1905.
RUDOLF GALE.

At Station	B. S. Station	Angle A. Ver.	Angle B. Ver.	Vert. Angle.	Slope Dist.	Hor. Dist.	Mag. Course.	True Course.	To Station	Remarks.
1	.			2°	496.2	495.9	S. 81° W.	S. 81° 32' W.	2	No. 1 = 30 E. of dis. shaft.
2	1			5° 30'	250.9	249 7	S. 81° 30' W.	S. 81° 32' W.	3	
3	2			0°	190.0	190.0	S. 81° 30' W.	S. 81° 32' W.	4	End line.
1	.			0°	185.6	185 6		S. 81° 32' W.	1a	Center side stakes.
1				3° 30'	167.1	166.7	N. 81° 15' E.	N. 81° 32' E.	5	
5	1			10°	188.5	185.6	N. 81° 30' E.	N. 81° 32' E.	6	
6	5			8°	214.1	212.1	N. 81° 15' E.	N. 81° 32' E.	7.	End line.
3	2	352° 3'	172° 3'	6° 30'	325.0	322.8	N. 74° E.	N. 73° 35' E.	1-14950	Columbus lode.

2°	490. = 489.7	5° 30'	250. = 248.8	495.9	1500.0		
	6.2 = 6.2		9 = .9	249.7	1287.9		
	496.2 = 495.9		250.9 = 249.7	190.0			
3° 30'	160. = 159.7	10°	180. = 177.3	168.7	212.1		
	7.1 = 7.0		8.5 = 8.3	185.6			
	167.1 = 166.7		188.5 = 185.6	1287.9			
	8°	210. = 208.0					
		4.1 = 4.1					
		214.1 = 212.1					

Dis. 16th March, 1905.

tainable, are marked Cor. No. 1, N. W. Cor.; and Cor. No. 2, S. W. Cor., Good Samaritan Lode, respectively.* From No. 3 a tie is made to Cor. No. 1, Sur. No. 14950 Columbus Lode, as shown in the notes. As we have now measured 935.6 feet, we know that we have passed the point for setting center side stakes, so we return to No. 1 and measure back 185.6 feet to No. 1a, whence the center side stakes are set at right angles to the center line. They are marked North and South Center Side Stakes, Good Samaritan Lode, respectively. Of course it frequently happens that the position of the center side stakes is known in advance and in this case a measurement would have been made in the beginning to No. 1a. In this case No. 1a would have been called No. 2 and the next sight might have been made to No. 3, etc., but in the case of the Good Samaritan Lode the center side stakes could not be placed till the claimant had decided where the claim was to end in its westerly course. We now extend the line through No. 5 and No. 6 and here knowing that the survey can be completed with another sight, the previous measurements are reduced to horizontals, the total subtracted from 1,500 and the result laid out. Corners No. 3 and No. 4 are then set as for the westerly end. If a tie has not been made to a patent corner, or some other proper monument, as above, the instrument is set up at some corner of the claim, preferably Cor. No. 1, and bearings to two or more mountain peaks or other permanent points taken and recorded. The surveyor then makes sure that he has the name of the lode, a description of the discovery, whether shaft, cut, etc., the correct name of the locators, the name of the mining district and the date. At his office the surveyor figures the

*While the law requires that the corners shall be marked by substantial stakes or other monuments, it does not require any inscription on them, and this may be omitted and the location yet be perfectly legal.

tie to the patented claim as given below, writes out the certificate, usually signs it for the claimant, and sends it for record to the county recorder. There are several styles of blank forms for location certificates sold by different publishers, but they are all essentially the same. The location certificate of above is as follows:

STATE OF COLORADO, }
County of Gilpin. } ss.

Know All Men by These Presents: That **Rudolf Gale**, the undersigned, has this **29th day of May, 1905**, located and claimed, and by these presents does locate and claim by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, **1,500** linear feet and horizontal measurement on the Good Samaritan lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with **75** feet on each side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges, or deposits and surface ground within the lines of said claim **594.4** feet running **N. 81° 32′ E.** from center of discovery **shaft** and **905.6 feet** running **S. 81° 32′ W.** from center of discovery **shaft**, said discovery **shaft** being situate upon said lode, vein, ledge or deposit, and within the lines of said claim in **Russell** Mining District, County of **Gilpin**, and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Cor. No. 1, whence Cor. No. 1, Sur. No. 14950, Columbus lode, bears N. 84° 57′ E. 510.56 feet, thence S. 8° 28′ E. 150 feet to Cor. No. 2, thence N 81° 32′ E. 750 feet to south center side stake, thence N. 81° 32′ E. 750 feet to Cor. No. 3, thence N. 8° 28′ W. 150 feet to Cor No. 4, thence S. 81° 32′ W. 750 feet to north center side stake,

thence S. 81° 32' W. 750 feet to Cor. No. 1, the place of beginning.

Said lode was discovered on the **16th day of March, A. D. 1905.**

Date of location, **May 29, A. D. 1905.**

Date of certificate, **May 29, A. D. 1905.**

RUDOLF GALE (Seal).

It is not necessary to mention the center side stakes in the description. Should several claimants desire to be recorded as possessing unequal shares, the names may be arranged as follows, at the bottom:

J. P. Smith, ½ interest.
L. S. Weaver, ¼ interest.
L. J. Walter, ¼ interest.

For a company, the name may simply be placed at the bottom with or without the addition of the name of an agent or attorney in fact.

Other examples of location certificates will be given under field notes of patent survey.

The above simple straight location may be varied in many ways. The end lines may not be at right angles to the center, but made to fit some other claim; in this case the end line is longer than the width of the claim, and is figured in the same way as the end line of an angular claim given later. In order to avoid conflicts, the claim is frequently made narrower than the legal width, sometimes on one side of the center, sometimes on both sides, and the side lines may even be broken lines. In this latter case they are figured as examples of mill sites or intersections of patents, etc., which will be given later. There is probably no legal objection to having the end line even longer than the side line as is the case in Fig. 19. In this example, were a mistake made and the vein

placed as shown in the figure, the claimant would get over 3,000 feet of vein in one location, provided the vein was perpendicular, so as not to require extralateral rights. At

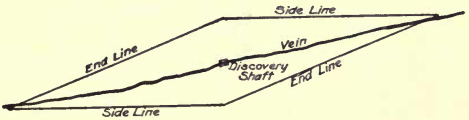


Fig. 19.

the time of issuance of patent of course this could not be known, as the vein is required, as far as known, to be not more than 75, 150 or 300 feet from either side line, according to the district.

Angular Claims.

In the case of angular claims the conditions given above are more or less complicated. The simplest angular claim is one whose one angle is at or near the discovery and therefore known in advance, or at least before either end line is laid out. This is easily surveyed, as follows: See Fig. 20, the angle a being determined as 40°. The angle b is equal to 140°. In placing the angle stakes the angle b is bisected, that is, 70° is turned from either the fore-sight or the back-sight on the southerly side, or 110° turned from either the fore-sight or back-sight on the northerly side. The bisecting line is therefore 20° in each case from a line at right angles to the lines 1—2 and 1—3. The direction of this line is seen at once to be in the figure above S. 30° E. (90°—80°=10°+20°=S. 30° E. 90°—40°=50°—20°=S. 30° E.). As one-half of this line is the hypothenuse of a right triangle whose base is 150

feet (or, as the case may be, 75 or 300 feet), and whose angle A is 20°, its length is found from a traverse table or table of natural secants to be:

	lat.		distance or nat. secant.		
20°	141.0	=	150.	20° = 1.0641	
	9.0	=	9.6	300	
	150.0	=	159.6	2)319.23	end line
				159.61	

which is the true distance from No. 1 to the angle corner S. 30° E. and also of course in the other direction N. 30° W. These lines in turn must be corrected for slope of hill. The end lines are then placed parallel to the line of the angle stakes, and the same length. The stakes are marked as

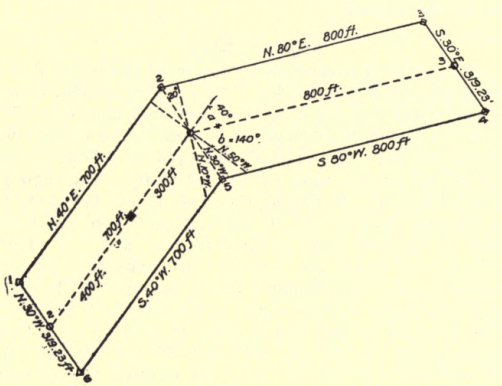


Fig. 20.

given under straight lode locations, except the angle stakes are marked Cor. No. 2 and Cor. No. 5 North and South angle stakes respectively. As the end lines and angle stake line are all parallel, the opposite side lines are the same length, therefore no figuring or checking up is required in the office and the location certificate may be written out at once. This certificate is exactly the same as in the case of a straight claim, except that in the best work, when the discovery shaft is not exactly at the angle, additional description is required; for example, in Fig. 20 it would be described " " " " claims 400 feet running S. 40° W. from centre of discovery shaft and 300 feet running N. 40° E. thence 800 feet running N. 80° E., etc.

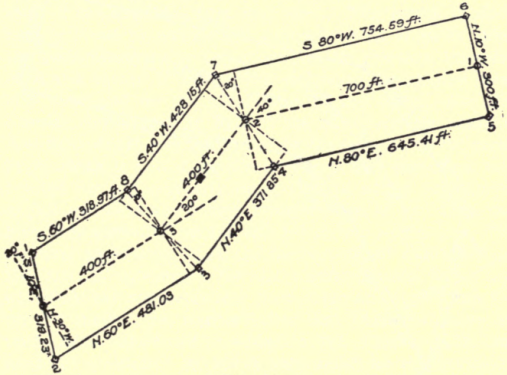


Fig. 21.

In surveying an angular claim where the angle is not known when the first end line is reached, or when there are two or more angles in the claim, this first end line is usually put in at right angles to the centre line. In the

case of a claim having only one angle, the setting of the end line may often be postponed till the angle of the centre line is determined. When the end line is set at right angles one or more sets of angle stakes are placed on lines bisecting the angles as given above but these lines are not parallel to the end lines, nor are they necessarily parallel to each other. As the end lines of the claim must be parallel to each other, this requires that the end line for No. 4 be turned from a line at right angles to its centre line over an angle equal to the algebraic sum of all the angles entering into the broken centre line of the claim, or from the back-sight on the centre line over the complement of this

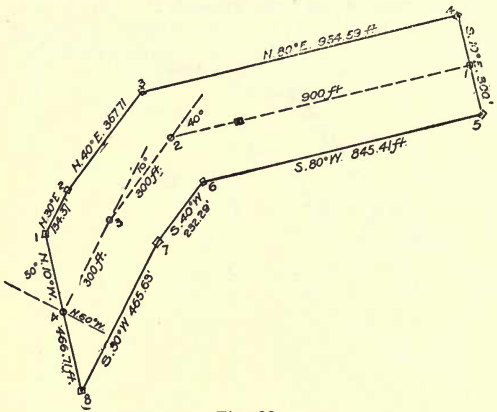


Fig. 22.

algebraic sum. This is shown in the two figures above, Fig. 21 and Fig. 22, to be 20° and 50° respectively as the deviation from a straight centre line is always to the right

or first to the right and then to the left; right figure as plus and left as minus.

The end line angle is thus the angle caused by the total change of direction of the centre line of the claims from its course No. 1–No. 2 to its course No. 3–No. 4.

The length of the end line is figured as the hypothenuse of a right triangle whose base is 300 feet (or 150 or 600 as the case may be) and whose angle A is the angle turned from a line at right angles to the centre line at that point. This in turn is corrected for the slope of the hill. While it is no more difficult to stake out this kind of an angular claim in the field than in the case of the angular claim first cited, the office work is more involved. The side lines opposite to each other are not of equal length, as in the case of the angular claim first cited. The length in each case is found by adding and subtracting on opposite sides the perpendiculars or departures, of the various triangles used and figured in setting the stakes, to the lengths actually measured on the centre line of the claim. For the angular claim given in Fig. 21 the most easterly angle is first figured, 150 feet multiplied by the tangent of 20° gives 54.59, which is added for the northerly side lines and subtracted for the southerly lines, that is, added to exterior angles and subtracted from interior ones, to and from the distances measured on 1–2 and 2–3 on tne centre line. For the next angle west 26.44, the tangent of 10° multiplied by 150 feet, is subtracted for the northerly side lines, and added for the southerly side lines, from and to 2–3 and 3–4 on the centre line, remembering that 54.59 feet have already been subtracted or added to 2–3. Finally 54.59, tangent 20° multiplied by 150 is subtracted for the northerly side line and added for the southerly side line to and from 3–4 to which 26.44 feet have already been subtracted and added. In Fig. 22 the same method is pursued. On the northerly side line the tangents are added until the end line is reached, then subtracted from the centre line distances

while for the southerly side line the tangents are subtracted until the end line is reached and then added. To be sure that the work has been done correctly and that the boundary lines close, a traverse is made as in the following examples. While the traverse may be made in the usual way, the labor is greatly decreased by subtracting the length of the side lines and end lines from each other, using the direction in each case of the longer line. We thus find latitudes and departures for only half of the courses and for smaller numbers. The closing of the traverse round the claim proves the correctness of the previous work.

Example.

	Course.	Dist'ce.	N.Lat.	S.Lat.	E. Dep.	W.Dep.
.....	S. 10° E.	19.23	.....	18.93	3.32	.....
Fig. 21..	N. 60° E.	162.06	81.05	.....	140.32	.....
.....	S. 40° W.	56.30	.....	43.11	.....	36.18
.....	S. 80° W.	109.18	.....	18.95	.....	107.52
			81.05	80.99	143.64	143.70
	Course.	Dist'ce.	N.Lat.	S.Lat.	E. Dep.	W.Dep.
.....	N. 10° W.	166.71	164.16	.....	.....	28.94
Fig. 22..	S. 30° W.	331.26	.....	286.86	.....	165.63
.....	N. 40° E.	135.42	103.72	.....	87.04	.....
.....	N. 80° E.	109.18	18.95	.....	107.52	.....
			286.83	286.86	194.56	194.57
	Course.	Dist'ce.	N.Lat.	S.Lat.	E. Dep.	W.Dep.
.....	N. 15° E.	25.72	24.85	.....	6.65	.....
Fig. 23..	S. 82° W.	60.82	.....	8.46	.....	60.22
.....	S. 73° E.	56.04	.....	16.38	53.58	.....
			24.85	24.84	60.23	60.22

It frequently happens that in case of angular claims, the end lines must be made to fit prior claims. In this case the calculations for the amounts to be added to the length of the centre line must be made at each end of the claim as well as at the angles, and the amounts to be added and the lengths of the line will vary according to the angle at which the latter are set. See Fig. 23. Angular claims may also be narrowed down and located with irregular side lines, but the figuring of these variations is only a

form of the figuring done in such work as patent intersections treated later on.

In the case of all lode locations the setting of end lines is of great importance. The end lines should be placed as a rule as nearly as possible at right angles to the strike of the vein, while the location survey covers the apex.

The dip of the lode and the extralateral rights desired should always be kept in mind by the surveyor. Thus in Fig. 23 the arrangement of end lines there placed so as to

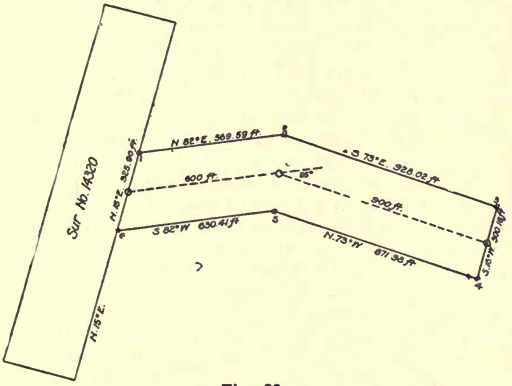


Fig. 23.

avoid conflict with the prior location may not be the best or may be extremely bad when the question of extra lateral rights is considered. It is therefore often best not to survey to avoid a conflict but to make the best possible arrangement of end lines to cover the ground desired.

Relocation and Amended Certificates.

"Distinction Between Relocation and Amended Certifi-

cate.—In strictness there is a relocation only when some change is made upon the ground, as by changing length, width or boundaries; perhaps also when overlapping abandoned ground is taken. The certificate filed to show such change is a relocation certificate. But if the error is in the papers only, as by a misleading or too vague description, there is no relocation, but only the filing of an amended location certificate. But the terms are not always used with exactness even by the legal profession, all such papers as well as acts being called relocations or relocation certificates, and a misuse of the term is not generally material.—Cheeseman vs. Shreeve, 40 Fed. 789." —Morrison's Mining Rights, p. 109, 10th ed.

It frequently happens especially just before surveying for patent, that the descriptions of claims are found to be defective in some respect, and in this case an amended description is filed, and no change is made upon the ground. More often, however, the stakes on the ground are changed somewhat, and the owner takes advantage of a resurvey to take in some abandoned ground, or to alter the lines of his claim slightly one way or the other from the original location. He may even make radical changes in direction of lines and extent of territory embraced. In this event there is no change in the method of survey from the procedure in the case of the original location, but the certificates are worded to suit the case. Of the two examples which follow of amended and relocation certificates, the first is rarely used, as the second covers almost every possible case. In some cases it is well to state the cause for amending, as for example, to state that it is to correct the spelling of the name of the claim or location. This assumes importance when it is desirable to impress suspicious neighbors with the fact that no change has been made in the boundaries of a claim, but an amendment made simply to perfect the description.

In the case of a second amendment we add to "This being the same lode, * * *" "and again located on the 18th day of April, 1905, and recorded on the 21st day of April, 1905, in book 160, page 352, in the office of the recorder of Clear Creek county."

Additional and Amended Location Certificate—Law of 1889.

STATE OF COLORADO, }
County of Clear Creek, } ss.

Know All Men by These Presents, That**The Treasure Vault Gold Mining Company** has, this **18th** day of **April**, 1905, amended, located and claimed, and by these presents does amend, locate and claim, by right of the original discovery and this additional and amended location certificate, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General Statutes of Colorado, and with local customs, laws and regulations, **717.2** linear feet and horizontal measurement on the **BOREAS** lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with **75 feet** on each side of the middle of said vein at the surface, so far as can be determined from present developments, and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, **10** feet running **northeasterly** from center of discovery **shaft** and **707.2** feet running **southwesterly** from center of discovery **shaft**, said discovery **shaft** being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in **Idaho Mining** District, County of **Clear Creek** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence **S. 14° 15' E. 152.48 ft. to Cor. No. 2; thence S. 65° 24' W. 377.33 ft. to Cor. No. 3; thence S. 89° 2' W. 339.79 ft. to Cor. No. 4; thence N. 14° 15' W. 154.12 ft. to Cor. No. 5; thence N. 89° 2' E. 343.81 ft. to Cor. No. 6; thence N. 65° 24' E. 373.47 ft. to Cor. No. 1, the place of beginning.**

From Cor. No. 1, Cor. No. 3, Sur. No. 12276, Bessie lode bears N. 14° 15' W. 7.66 ft.

This being the same lode originally located on the 21st day of February, 1901, and recorded on the 2nd day of March, 1901, in book 147, page 319, in the office of the Recorder of Clear Creek County. This further additional and amended certificate of location is made without a waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record, and making more specific the boundaries and description of said lode as originally located upon the ground.

THE TREASURE VAULT GOLD MINING CO.
[Seal.] By J. P. Little, Agent.

Said lode was discovered the 15th day of February, A. D. 1901.

Date of additional and amended certificate, April 18th, A. D. 1905.

Additional and Amended Location Certificate—Law of 1889.

STATE OF COLORADO, }
County of Clear Creek, } ss.

Know All Men by These Presents, That The Treasure Vault Gold Mining Company has, this 18th day of April, 1905, amended, located and claimed, and by these presents does amend, locate and claim, by right of the original discovery and this additional and amended location certificate, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General Statutes of Colorado, and with local customs, laws and regulations, 1014.2 linear feet and horizontal measurement on the ARC LIGHT lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 75 feet on each side of the middle of said vein at the surface, so far as can be determined from present developments, and

all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 21 feet running N. 61° 37' E. from face of discovery cut and 993.2 feet running S. 61° 37' W. from face of discovery cut, said discovery cut being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in Idaho Mining District, County of Clear Creek and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence S. 28° 23' E. 150 ft. to Cor. No. 2; thence S. 61° 37' W. 1014.2 ft. to Cor. No. 3; thence N. 28° 23' W. 150 ft. to Cor. No. 4; thence N. 61° 37' E. 1014.2 ft. to Cor. No. 1, the place of beginning.

From Cor. No. 1, Chief Mt. bears S. 5° W. and a prominent peak bears S. 30° W.

This being the same lode originally located on the 21st day of February, 1901, and recorded on the 2nd day of March, 1901, in book 147, page 320, in the office of the Recorder of Clear Creek County. This further additional and amended certificate of location is made without a waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record, and of taking in and acquiring all forfeited or abandoned, overlapping ground, and of taking in any part of any overlapping claim which has been abandoned, and of securing all the benefits of said Section 2409 of the General Statutes of Colorado.

THE TREASURE VAULT GOLD MINING CO.
[Seal.] By J. P. Little, Agent.

Said lode was discovered the 15th day of February, A. D. 1901.

Date of additional and amended certificate, April 18th, A. D. 1905.

Mill Sites and Placers.

Mill sites and placers are for the most part on streams. Placers are required by the General Land Office to be taken up by legal subdivisions when on surveyed lands. When the land is not surveyed, as is often the case with mineral lands, placers should be surveyed as regularly as possible.

As a rule the surveyor will lay out a millsite in rectangular form for simplicity, and the following table taken from Morrison will often be useful:

"Area in Feet or Acres.—By the following table the number of feet necessary to include any desired number of acres when in the shape of a square or parallelogram may be ascertained:

Claim	660	×	330	feet	contains	5	acres.
"	500	×	500	"	"	5.73	"
"	660	×	660	"	"	10	"
"	1320	×	660	"	"	20	"
"	800	×	1089	"	"	20	"
"	933⅓	×	933⅓	"	"	20	"
"	1320	×	1320	"	"	40	"
"	2640	×	2640	"	"	160	"

43,560 square feet = 1 acre. A square 208.71 feet in length and width = 1 acre."—Morrison's Mining Rights, p. 185, 10th ed.

It may happen that the survey must follow the meandering of a stream, and in this case the rules for angular claims may often apply. Even when the claim must be widened or narrowed the same rules hold, each portion be-

Fig. 24.

ing figured separately as in Fig. 24, the whole forming five acres or less in the case of a mill site, and twenty acres or less for each claimant in a placer. The end lines, if they may be so called, need not, of course, be parallel as in the case of lode locations. In case all ground possible is desired between two claims, A and B, Fig. 25, the centre

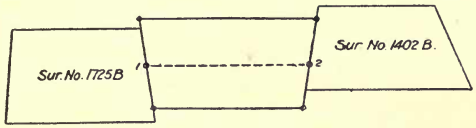


Fig. 25.

line 1–2 is measured and the width of claim then laid out, which will give 217,800 square feet (five acres) when multiplied by the length of 1–2. The end lines are figured as in angular claims. In case 1–2 is not the centre line, more figuring is of course required.

It sometimes happens that very irregular tracts must be laid out and there is no escape from more or less exten-

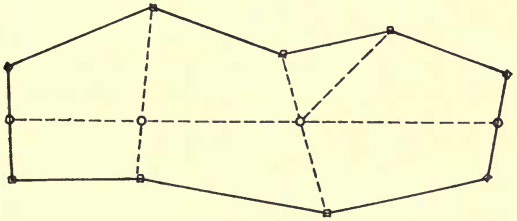


Fig. 26.

sive figuring to get the correct boundaries for the number of acres to be included. It will then be necessary to divide the area under consideration into rectangles or triangles,

CENTURY MILL SITE.

Course.	Distance.	N	S.	E.	W	D M. D	+	—	+ Areas.	— Areas
S 79° 5' E	300		56.81	294.56		294.56		56.81		16733 9
North	148	148				589.12	148		87189.8	
S 72° 13' E	210		64.13	199.96		789.08		64.13		50603.7
South	80		80.00			989.04		80		79123.2
S 73° 2' E	474.5		146.35	451.33		1440.37		146.35		210798
South	88		88.00			1891.70		88		166470
N 88° 32' W	946.18	24.26			945.85	945 85	24.26		22946.3	
North	263	263					263			
		435.26	435.29	945.85	945.85				110136.1	523728.8
										110136.1
										2)413592.7
										206796.3

4.747 acres.

log 206796.3 = 5.3155427
colog 43560 = 5.3609121
log 4.747 = 0.6764548

or both, or calculate the area by double meridian distances. The method of surveying will also vary according to circumstances of the case. It may be possible to survey from a centre line as in Fig. 26, or in the case of large tracts it may be necessary to run the exterior boundaries. Ties should be made as for all lode claims.

In any case, except when rectangular tracts are surveyed, the final description must be carefully checked by traverse as in the case of the angular claims, to make sure of a closure, and the area figured by double meridian distances.

Double Meridian Distances.

The traverse is begun with the most easterly or westerly station (Fig. 27). Double Meridian Distances = D.M.D., of preceding course plus the departure of that course, plus

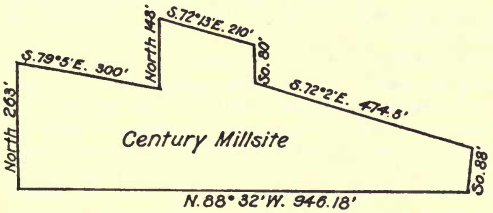


Fig. 27.

the departure of the course itself. The first and last D. M. D. is the same as the respective departures. The latitudes are arranged plus and minus North and South respectively, multiplied by their D. M. D. as above. The plus and minus areas resulting are then added and the lesser subtracted from the greater and the result divided by 2. The result is the area in square feet.

Care must be taken in the case of a mill site that is

cut into tracts by other claims to locate the mill site as one unit not including more than five acres, and during the patent surveying cut into tracts. A placer may be done the same way or at present writing may exclude other ground exactly as a lode claim. Examples of location certificates are as follows:

Location Certificate—Mill Site.

STATE OF COLORADO, }
County of Clear Creek, } ss.

To All Whom These Presents May Concern:

Know ye that I, John T. McDonald, of Idaho Springs, Colorado, do hereby declare and publish as legal notice to all the world that I have a valid right to the occupation, possession and enjoyment of all and singular that tract or parcel of land not exceeding five acres, situate, lying and being in Montana Mining District, in the County of Clear Creek, in the State of Colorado, bounded and described as follows, to-wit:

The CENTURY Mill Site, beginning at Corner No. 1, whence Cor. No. 6, Sur. No. 1465, Cohos Mill Site, bears N. 16° 42' W. 27.6 ft.; thence S. 79° 5' E. 300 ft. to Cor. No. 2; thence N. 148 ft. to Cor. No. 3; thence S. 72° 13' E. 210 ft. to Cor. No. 4; thence S. 80 ft. to Cor. No. 5; thence S. 72° 2' E. 474.5 ft. to Cor. No. 6; thence S. 88 ft. to Cor. No. 7; thence N. 88° 32' W. 946.18 ft. to Cor. No. 8; thence N. 263 ft. to Cor. No. 1, the place of beginning.

Containing 4.747 acres, together with all and singular the hereditaments and appurtenances thereto belonging or in any wise appertaining.

Witness my hand and seal, this 26th day of December, in the year of our Lord one thousand nine hundred and three.

[Seal.] JOHN T. McDONALD.

STATE OF COLORADO, }
County of Clear Creek, } ss.

Before me, the subscriber, a Notary Public in and for

said County, personally appeared John T. McDonald, to me personally known to be the same person described in and who executed the within Declaration of Occupation, and acknowledged that he signed, sealed and published the same as his free and voluntary act and deed, for the uses and purposes therein set forth.

Witness my hand and notarial seal, this twenty-sixth day of December, A. D. 1903.

My commission expires December 27, 1905.

ROYAL R. GRAHAM, Notary Public.

(Note.—The certification before a Notary is not necessary. Another example of Mill Site Certificate will be given under Field Notes of Patent Surveying.)

Placer Location Certificate.

Know All Men by These Presents, that J. M. Cross, the undersigned citizen of the United States, resident of the County of Clear Creek, State of Colorado, having complied with the provisions of Chapter 6, Title XXXII., of the Revised Statutes of the United States, and with the local customs, laws and regulations, claims by right of discovery and location the SNOW STORM Placer Claim, situate, lying and being in Gold Dirt Mining District, County of Clear Creek, and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence N. 81° 42' E. 329.85 ft. to Cor. No. 2; thence S. 35° 3' E. 227.6 ft. to Cor. No. 3; thence S. 44° 46' W. 213.6 ft. to Cor. No. 4; thence N. 68° 34' W. 422.30 ft. to Cor. No. 1, the place of beginning.

From Cor. No. 1, two prominent peaks bear N. 87° 30' W. and S. 45° W. respectively.

Containing an area of 1.808 acres, said claim was located on the 19th day of November, A. D. 1902.

Date of certificate, December 1st, A. D. 1902.

J. M. CROSS.

(A Placer Location Certificate by legal subdivisions will be given under Field Notes of Patent Surveying.)

Tunnel Sites.

There is considerable difference of opinion in regard to the location of tunnel sites, but the best method seems to be the surveying of the proposed line of the tunnel on the surface, and the marking of the exterior boundaries of the tunnel site. The tunnel line is easiest marked by stakes

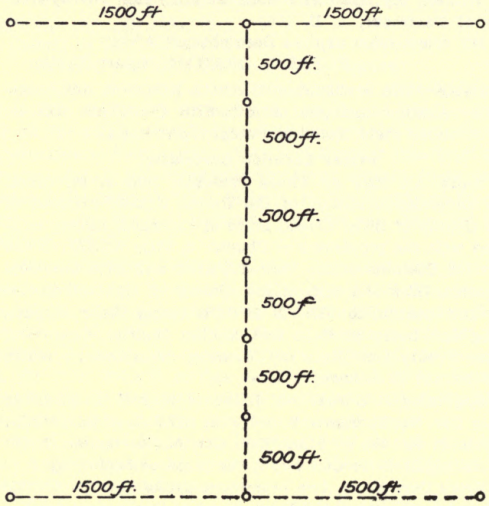


Fig. 28.

at the various points of set up but rather better by stakes set at regular intervals of say 500 feet. From the end points stakes are set 1,500 feet on each side of the tunnel line as shown in Fig. 28. Certain ground is frequently located or staked for dumping purposes.

Location Certificate—Tunnel.

To All Whom These Presents May Concern:

Know ye that I, George E. Plant, of Georgetown, Colorado, on the 20th day of May, 1905, located, and by these presents do locate, for the discovery of mines and the development of lodes or veins, the TIP TOP Tunnel and Tunnel Site, and claim the right of occupancy, possession and enjoyment thereof, together with the right of possession of 1,500 feet in length on all veins or lodes within 3,000 feet from the face of said tunnel, on the line thereof, not previously known to exist, discovered in said tunnel, situate in Virginia Mining District, Clear Creek County, State of Colorado.

The mouth of the tunnel (at the point where it enters cover) is located on the North side of Cold Creek, whence Cor. No. 2, Sur. No. 16521, Colorado lode, bears S. 27° 16' W. 351.5 ft.

Size of tunnel, 6 feet wide by 8 feet high in the clear.

Course of tunnel from its mouth is North 3,000 feet.

A full description of the stakes set along the line of tunnel is as follows: Six stakes set at intervals of 500 feet for 3,000 feet from mouth.

A full description of the stakes set at the exterior boundaries of the area claimed, 3,000 feet square is as follows: From mouth of tunnel stakes set 1,500 feet west and 1,500 feet east respectively. At 3,000 feet from mouth, stakes set 1,500 feet west and 1,500 feet east respectively.

I also claim for dumping purposes a tract of land described as follows: Beginning at the mouth of said tunnel, thence E. 100 ft.; thence S. 200 ft.; thence W. 200 ft. thence N. 200 ft.; thence E. 100 ft. to place of beginning, together with all and singular the hereditaments and appurtenances thereunto belonging or in any wise appertaining, and all rights granted to the locator as tunnel rights under the terms of Section 2323 of the Revised Statutes of the United States.

Witness my hand and seal this 20th day of May, A. D. 1905. [Seal.] GEORGE E. PLANT.

Legal Subdivisions.

Locating placers by legal subdivisions of sections is closely connected with the procedure for restoring lost corners of the public survey. The subject is exhaustively handled in "Circular on Restoration of Lost or Obliterated Corners and Subdivision of Sections: General Land Office, March 14, 1901." The pamphlet may be obtained by applying to the General Land Office, Washington, D. C. Following is an account of the most important points to be kept in mind and principles to be applied. An example of the Location Certificate required will be given with the Field Notes of a Patent Survey.

General Rules.

1st. That the boundaries of the public lands established and returned by the duly appointed government surveyors, when approved by the surveyors general and accepted by the government, are unchangeable.

2nd. That the original township, section and quarter-section corners established by the government surveyors must stand as the true corners which they were intended to represent, whether the corners be in place or not.

3rd. That quarter-quarter corners not established by the government surveyors shall be placed on the straight lines joining the section and quarter-section corners and midway between them, except on the last half-mile of section lines closing on the north and west boundaries of the township, or on other lines between fractional sections.

4th. That all subdivisional lines of a section running between corners established in the original survey of a township must be straight lines running from the proper corner in one section line to its opposite corresponding corner in the opposite section line.

5th. That in a fractional section where no opposite cor-

responding corner has been or can be established, any required subdivision line of such section must be run from the proper original corner in the boundary line due east and west, or north and south, as the case may be, to the water course, Indian reservation or other boundary of such section, with due parallelism to section lines.

From the foregoing it will be plain that extinct corners of government surveys must be restored to their original locations whenever it is possible to do so; and hence resort should always be first had to the marks of the survey in the field. The locus of the missing corner should be first identified on the ground by the aid of the mound, pits, line trees, bearing trees, etc., described in the field notes of the original survey.

The identification of mounds, pits, witness trees or other permanent objects noted in the field notes of survey, affords the best means of relocating the missing corner in its original position. If this can not be done, clear and convincing testimony of citizens as to the locality it originally occupied should be taken if such can be obtained. In any event, whether the locus of the corner be fixed by the one means or the other, such locus should always be tested and confirmed by measurements to known corners. No definite rule can be laid down as to what shall be sufficient evidence in such cases, and much must be left to the skill, fidelity and good judgment of the surveyor in the performance of his work.

Subdivision of Sections.

1. Subdivision of Sections into Quarter Sections.—Under the provisions of the Act of Congress approved February 11, 1905, the course to be pursued in the subdivision of sections into quarter sections is to run straight lines from the established quarter section corners, United States surveys, to the opposite corresponding corners. The point of intersection of the lines thus run will be the corner

common to the several quarter sections, or, in other words, the legal center of the section.

(a) Upon the lines closing on the north and west boundaries of a township, the quarter section corners are established by the United States deputy surveyors at 40 chains to the north or west of the last interior section corners, and the excess or deficiency in the measurement is thrown into the half mile next to the township or range line, as the case may be.

(b) Where there are double sets of section corners on township and range lines, the quarter corners for the sections south of the township lines and east of the range lines are not established in the field by the United States deputy surveyors, but in subdividing such sections said quarter corners should be so placed as to suit the calculations of the areas of the quarter sections adjoining the township boundaries as expressed upon the official plat, adopting proportionate measurements where the new measurements of the north or west boundaries of the section differ from the original measurements.

2. Subdivision of Fractional Sections.—Where opposite corresponding corners have not been or cannot be fixed, the subdivision lines should be ascertained by running from the established corners due north, south, east or west lines, as the case may be, to the water course, Indian boundary line or other boundary of such fractional section.

(a) The law presumes the section lines surveyed and marked in the field by the United States deputy surveyors to be due north and south or east and west lines, but in actual experience this is not always the case. Hence, in order to carry out the spirit of the law, it will be necessary in running the subdivisional lines through fractional sections to adopt mean courses where the section lines are not due lines, or to run the division line parallel to the east, south, west or north boundary of the section, as con-

ditions may require, where there is no opposite section line.

3. Subdivision of Quarter Sections into Quarter-Quarters.—Preliminary to the subdivision of quarter sections, the quarter-quarter corners will be established at points midway between the section and quarter section corners, and between quarter corners and the center of the section, except on the last half-mile of the lines closing on the north or west boundaries of a township, where they should be placed at 20 chains, proportionate measurement, to the north or west of the quarter section corner.

(a) The quarter-quarter section corners having been established as directed above, the subdivision lines of the quarter section will be run straight between opposite corresponding quarter-quarter section corners on the quarter section boundaries. The intersection of the lines thus run will determine the place for the corner common to the four quarter-quarter sections.

4. Subdivision of Fractional Quarter Sections.—The subdivision lines of fractional quarter sections will be run from properly established quarter-quarter section corners (paragraph 3) due north, south, east or west, to the lake, water course or reservation which renders such tracts fractional, or parallel to the east, south, west or north boundary of the quarter section, as conditions may require. (See paragraph 2-a.)

5. Proportionate Measurement. — By "proportionate measurement," as used in this circular, is meant a measurement having the same ratio to that recorded in the original field notes as the length of chain used in the new measurement has to the length of chain used in the original survey, assuming that the original and new measurements have been correctly made.

For example: The length of the line from the quarter section corner on the west side of Sec. 2, T. 24 N., R. 14 E., Wisconsin, to the north line of the township, by the United

States deputy surveyor's chain, was reported as 45.40 chains, and by the county surveyors measure is reported as 42.90 chains; then the distance which the quarter-quarter section corner should be located north of the quarter section corner would be determined as follows:

As 45.40 chains, the government measure of the whole distance, is to 42.90 chains, the county surveyor's measure of the same distance, so is 20.00 chains, original measurement, to 18.90 chains by the county surveyor's measure,

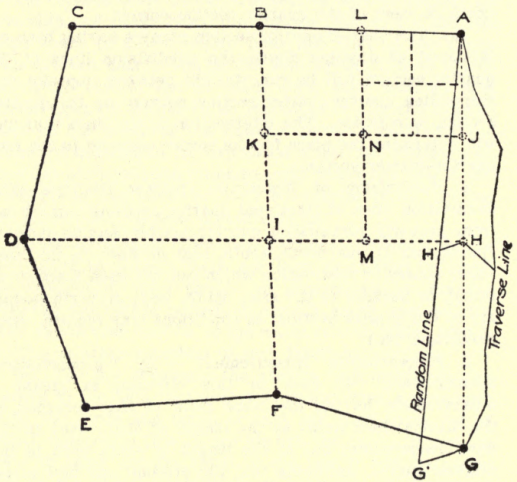


Fig. 29.

showing that by proportionate measurement in this case the quarter-quarter section corner should be set at 18.90

chains north of the quarter section corner, instead of 20.00 chains north of such corner, as represented on the official plat. In this manner the discrepancies between original and new measurements are equitably distributed.

The foregoing will be clear from an inspection of Fig. 29. We will assume that the corners actually existing on the ground are represented by the points A B C D E F G, while corner H is missing. This corner is re-established by placing it on a straight line half way between A and G. When the character of the country permits, this had best be done by running a random line, (straight trial line), as nearly direct from A to G as possible. This line will probably fall somewhat to the east or west of G, say at G'. From G' the course and distance is measured to G. At a point half way between A and G' on the line AG' run a line parallel to G'G and half the length of G'G, to H. Thus H is on line AG equidistant from A and G.

In rough country it will often be easier or even necessary to run a traverse from A to G, figure the missing course, and thus find the course and distance directly from A to G. Half of this distance is the distance from G to H. This may either be run directly on the ground from G or A, or better still the position for H may be found by figuring the course and distance from the nearest station used on the traverse from A to G, for which all the latitudes and departures have been previously figured in order to determine AG.

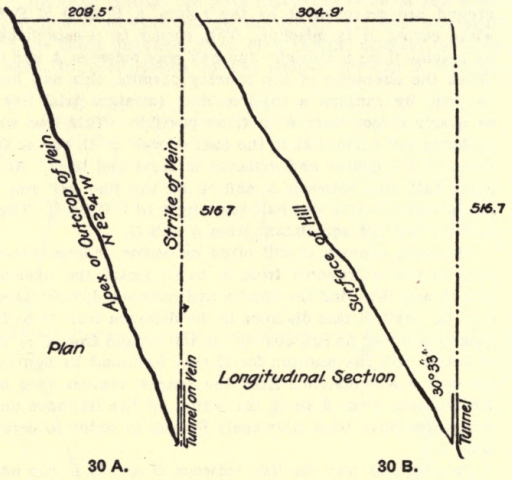
In a similar way the line between H and D is run and its interior corner I is established at the point of its intersection with the line BF. Midway between B and I, K is established, and J between A and H. Half way between A and B establish L and similarly M between H and I. This same principle will determine the re-establishment of lost corners, or the subdivision of the whole section.

Should the section be on the western tier of the township, it must be remembered that the eastern portions of

the sections are subdivided as nearly as possible according to the dimensions of a perfect section, and all the error thrown into the western portion.

Tracing Extensions of Veins on the Surface.

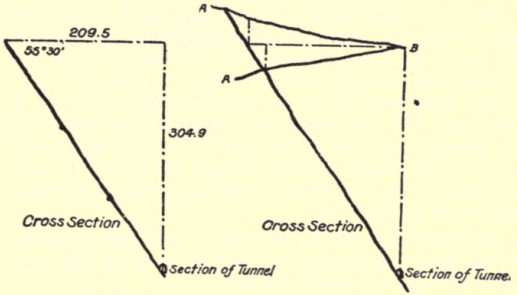
On the borderland between surface and underground



surveying one of the operations that a western surveyor is frequently called upon to perform is tracing the extension of a known vein or finding from underground workings the probable outcrop of a vein. This may be done with various solars with great ease as afterwards described, but with an ordinary transit it requires considerable calculation.

Let Fig. 30 in plan, vertical and longitudinal section, represent the simplest possible case, a vein striking due

north and running up a regularly sloping hillside. The problem is to find the direction of the apex and the point on the surface approximately 600 feet away where the vein outcrops. From the tunnel the strike of the vein is found to be north, or assumed to be so for simplicity, and the dip is found to be 55° 30′. Measuring 600 feet up the hill north, the same direction as the tunnel is assumed, the angle of elevation is found to be 30° 33′, which gives us a perpendicular height of 304.9. From this, with the angle of dip 55° 30′, we find we have to measure 209.5



30 C. 30 D.

feet at right angles to the strike to reach the apex. Should the course only of the apex be desired, we have only

$$\frac{516.7}{209.5} = \cot \text{course}$$

$$\log 516.7 = 2.713238$$
$$\log 209.5 = 2.321184$$
$$0.392054 = \log \cot 22° 4'$$
or N. 22° 4′ W.

It will usually happen, however, that A is not on a level with B, and therefore some correction must be added or subtracted to 209.5 feet as the point A is above or below B as shown in Fig. 30 D. This correction, of course, varies

as the height varies above or below B, and is figured from this height with an angle of 55° 30′ as the 209.5 feet was figured from 304.5 feet in Fig. 30 C.

Vein Tracing with the Solar Attachment.

By using the Shattuck Solar Attachment this becomes a very simple operation and is performed as follows:

The dip and strike of the vein are first determined by any convenient means. Then set the transit over an outcrop of the vein and attach the solar with the mirror set to deflect the line of collimation through an angle of 90°.

Point the telescope in a direction perpendicular to the plane of the vein, which is done by deflecting an angle of 90° from the strike of the vein, and setting off on the vertical limb an angle of 90° from the dip of the vein.

The Solar revolved on its axis will then cut a plane of the vein. The line where this plane cuts the surface of the ground is the line of the apex of the vein, which may be traced by simply sighting through the Solar. Its position may be marked where it crosses gulches or hillsides with equal facility.

In case there are two openings at different elevations on the apex of a slanting vein, the strike of the vein may be determined in a similar manner.

Place the transit, with Solar attached, over one of the croppings; depress the telescope to an angle of 90° plus the dip of the vein and direct the telescope toward the footwall of the vein. Sight through the transit and solar at the other outcrop, when the vernier reading will be 90° from the strike of the vein.

In a similar way the same results may be obtained by the use of a solar provided with a telescope, as for example, the Berger or Saegmuller Solars. For vein tracing the auxiliary telescope of the solar is set exactly parallel to the main telescope of the transit in the same vertical plane. The auxiliary telescope is then pointed in the di-

rection of the dip, as for example, down a shaft, and at right angles to the strike of the vein. If the auxiliary telescope is now revolved on the adaptor or whatever device is employed, on a plane parallel to the plane of the vein, it will always point to the same spot on the outcrop, provided, of course, the dip and strike are regular. In this way the outcrop may be staked by sighting directly through the telescope, a process somewhat simpler and clearer than the reflections of the Shattuck Solar.

The telescope alone of a mining transit may be used, provided it will turn on the point of attachment as in the Scott model. This may be turned, after it is tightly set, by loosening the capstan screw.

CHAPTER V.

Surveying for Patent.

We now come to that portion of western mineral surveying where the assistance of a deputy mineral surveyor is required, namely, surveying for patent. As a rule, before beginning patent proceedings, the correctness of the location surveys is carefully verified, or the surveys are corrected and modified as required. In the case of groups it is especially necessary that the exact status of things be known before an order for survey is requested from the Surveyor General. This done, the claimant or his attorney deposits the fees for the Surveyor's General Office at the nearest United States depository, with the name of the claimant and the name of the claim to which the fees are to apply.

He then, on the proper blanks which are supplied by the Surveyor General, applies to the Surveyor General to issue an order for survey. This form is given later under Specimen Field Notes. With this application are forwarded certified copies of the location certificates.

At the present writing the deputy mineral surveyor is strictly forbidden either to send the money to the United States depository, or make out the application to the Surveyor General for survey, and is strictly forbidden to act as attorney in any way for the claimant. This also applies to his chainman.

The certified copies of location certificates are carefully examined in the Surveyor's General Office, and if any mistakes are found, are returned for correction. Here it may be observed that the commonest mistakes found in these certificates are in angular claims which fail to close. If the certificates are satisfactory they are copied in the

Surveyor's General Office and the copies, with the order of survey, are sent to the United States deputy mineral surveyor designated in the application.

This order is also given later under Specimen Field Notes.

The deputy surveyor then surveys the claim exactly as described for a location survey, except that the work is done much more carefully, and with greater safeguards. In place of the stakes used in the location survey, stones, rocks in place, substantial posts, or even trees, are used for corners. If the ground is such that it is impossible to set a corner, or if it is seen that a corner can not possibly be permanent if set, a witness corner is placed on one of the lines of the survey but not except when absolutely necessary, off of these lines. Cor. No. 1 is placed on the end of the claim nearest the section corner or monument of the public survey, but it is not necessarily the nearest corner. Thus in Fig 31 one section tie serves for both

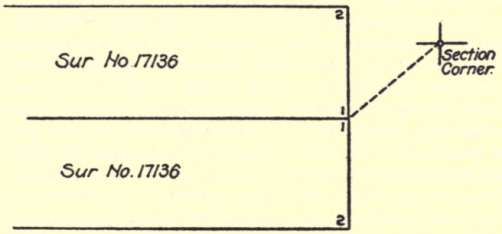


Fig. 31.

claims, which would not be the case should it be required to tie the nearest corner of the claim to the section corner and make it Cor. No. 1.

In case the surveyor has not carefully verified his location certificates in advance, he may find that the condi-

tions on the ground do not fit the descriptions in the certificates. Usually a slight divergence of a few minutes or a few feet is permitted by the Surveyor General. In case the divergence is material, it is then necessary to amend the locations and the claimant must apply for a new order for survey. This new order costs $5 and results in a new number being issued and a cancellation of the old number. Therefore it is stated again that too much care can not be taken to verify the descriptions in the location certificates before an order is requested.

Wherever possible, bearings are taken from the corners set to blazed trees, rocks in place, boulders, and, lastly, to mountain peaks, or permanent objects. The blazed trees and stakes are marked with a timber scribe, and the rocks and stone corners are chiseled.

The tie to a section corner may often be made directly from some convenient point during the process of the survey and the missing course figured from Cor. No. 1, as given above under location surveys. As a rule, more or less of a traverse must be made to the section corner and afterwards the direct course from Cor. No. 1 is figured. When the surveyor has a claim that he has previously surveyed for patent in the vicinity, which is tied to a section corner, he may run to this claim and figure his section tie through it. Should he tie through any other claim not his own survey, the work must be thoroughly checked. This practically means that he can use another's survey only as a help to find the section corner. The traverse to the section corner in any case is filed on a special blank with the field notes in the Surveyor's General Office. Ties made to a United States locating monument are in every way the same as to section corners.

A general description of the corner or monument tied to must be given in the notes, examples of which will be given later on.

In many districts, such as, for example, the Clear

Creek and Gilpin districts, the work of connecting the corners of the public survey is greatly facilitated by a number of triangulation systems in which each station of the system is tied to some corner of the public survey. In some cases these triangulation systems are official, and figure on the maps in the Surveyor's General Office, but in most cases they are simply private aids. With these systems the deputy surveyor has simply to tie to some triangulation station, and at his office has the bearing and distance from this station (with its latitude and departure) all figured out to the section corner. He has only to add this latitude and departure to this traverse to the triangulation station in order to figure his section tie. The triangulation systems are also useful for deflecting lines.

Thus, one may set up on a triangulation station, sight to some other triangulation station, the course of which is known, and thence run to the claim to be surveyed, carrying the course with him. In this way the figuring of a direct observation is avoided. (Plate I.)

Ties to other claims are also made from the most convenient points on the survey, only as a rule they are much shorter than the section tie. In order to know exactly the position of each conflicting claim, ties must be made to every corner terminating a line in conflict with the claim being surveyed. In case some of the required corners on a conflicting claim are missing, the lines are treated in a manner to be described later on. In case no corners at all are to be found, and no bearing trees, bearing rocks, etc., it is necessary to tie to the discovery shaft of the conflicting claim. If the discovery shaft can not be identified, the claim must be treated descriptively, and this case will be taken up under examples of figuring. As with the corner of a public survey, the corners of all claims tied to must be described in a general way as stone, post, etc., and the markings noted.

All workings and improvements, such as shafts, tun-

nels, adits, buildings, etc., are tied in from convenient points on the survey, and the courses and dimensions taken. They are eventually figured to some corner of the claim.

Roads, gulches, creeks, hill crests, county lines, etc., are picked up in the course of the survey and enough of them run out so that they can be indicated on the map and the general direction and intersection with the boundaries of the claim known.

Up to this time the survey has been treated as though one location at a time were being surveyed, or in the case of many locations as if each one were being surveyed as a unit. In the case of groups of claims, the surveying may be often greatly simplified by a little forethought. This is evident in the case of those locations which lie side by side when one surveyed center line may serve for the whole group, the end lines being run from its two ends.

In the case of a whole group where the claims are irregularly arranged, it is well to make a closed traverse including all the discovery shafts before an application for an order of survey is made. This traverse is then platted and the claims arranged in the manner best suited to cover the veins and ground desired. The surveyor then figures out the fewest lines that can possibly be run which will take in all the corners and improvements. In this way the running of the center line of each claim is avoided. If the original traverse stakes have remained in place, it is often possible to put in many of the corners from them without further surveying. The surveyor must also make sure that he really has a group before the claimant applies for an order for survey, that is, that the claims actually conflict continuously or are contiguous, i. e., having boundary lines in common, and not just corner in certain cases.

After the survey is completed it is carefully platted, usually on a scale of 200 feet to the inch. The use of

drawing paper on which is engraved a protractor greatly facilitates the platting. The lines are carried from the protractor by a parallel rule. The plat made, the figuring of intersections and areas is begun.

Angles from Courses.

Before taking up patent figuring it will be well to show how the angles of the various triangles are found.

To determine the value of the various angles of triangles, the directions of whose sides are designated by courses, is somewhat confusing to the beginner, especially if he is not thoroughly familiar with field methods. Fig. 32, A, B, C and D, shows the four possible cases, the angles in question being the interior angles between solid lines. A shows the simplest possible case. Each course being S. W., we simply subtract 20° from 60° and get the angle

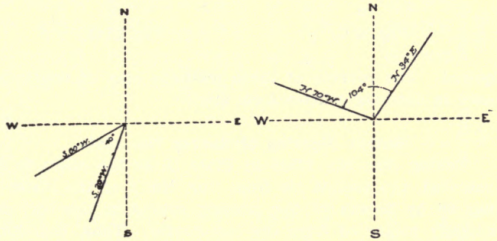


Fig. 32 A. Fig. 32 B.

40°. In B we have a case, on each side of the north and south line, and the amounts of the two courses have simply to be added to obtain the required angle. Thus 70°+34°=104°. In C the amounts of the two courses are added and the sum subtracted from 180°. Thus, 40°+55°=95°,

180°—95°=85°, or 90°—40°=50°, and 90°—55°=35°, 35°+50°=85°, the angle required. For D the included angle may be obtained in three different ways. The difference in course may be obtained and then subtracted from 180°, as 60°—20°=40°, 180°—40°=140°, or 180°—60°=120°+20°=140°, or 90°—60°=30°+90°+20°=140°, the angle re-

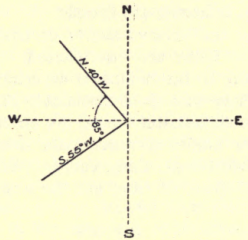


Fig. 32 C.

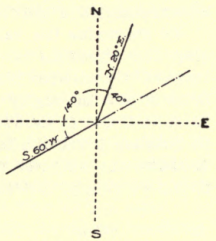


Fig. 32 D.

quired. The reverse of these methods may of course be used in deriving courses from angles.

Patent Figuring of Survey No. 17846.

Taking Sur. No. 17846 in Plate II. as the claim to be patented, the section tie from Cor. No. 1 of the claim is figured by means of the missing course of the traverse actually measured from the end center. Thus, beginning at Cor. No. 1, thence to No. 1, thence to No. 2, thence to No. 3, or the section corner, thence by missing course to Cor. No. 1.

PAGE FROM NOTE BOOK, SUR. NO. 17846.

At Stat'n	B. S. Stat'n	Vert. Angle	Slope Dist.	Hor. Dist.	True Course	To Stat'n	REMARKS.
1	0	0°		335.6	N 75° E	4	1=on end line
4	1	10°	294.6	290.1	N 75° E	7	
7	4	11° 15′	424.5	416.3	N 75° E	8	
8	7	6° 30′	461.0	458.0	N 75° E	9	On end line
				1500.0			
1	0	12°	405.2	396.2	N 81° W	2	For sec. tie
2	1	9°	333.7	329.5	N 50° W	3	= Sec. Cor. 6x9x16 ins. above ground, 1111 So.
1	0	0°	110		N 75° E		Dis. 4x6, 65 deep. Timbered 30 feet
4	1	10°	482.1	474.8	N 14° 46′ E	5	
5	4	5°	218.8	217.9	N 29° 39′ W		1—16591 stone
5	4	5°	232.5	231.5	N 54° 3′ E		2—16591 stone
4	1	0°		703.3	S 4° 2′ W	6	
6	4	4°	240.6	240.0	S 58° 19′ W		4—16591 stone
6	4	4°	201.7	201.2	S 26° 53′ E		3—16591 stone
4	1	3°	7.5	87.4	S 50° 16′ E		1—17541 stone
7	4	0°	56.6	56.6	S 89° 22′ W		2—17541 stone (No Cors. at S. end)
8	7	0°	62.3	62.3	N 40° 32′ W		2—12716 stone
2.12716				150.0	N 39° W		1—12716 stone
8	7	8°	151.0	149.5	S 45° 10′ E		4—17560 stone

No Cors. or disc found on 1462.

(Note Cors. 3 and 4—12716; Cors. 1, 2, 3, 5, 6—17560; known by previous official work.)

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
Cor. 1—No. 1.....	S. 15° E.	150.00	.....	144.88	38.82	.....
No. 1—No. 2.....	N. 81° W.	396.2	61.98	.....	.....	391.31
No. 2—3, Sec. Cor.....	N. 50° W.	329.5	211.79	.....	.....	252.41
			273.77	144.88	38.82	643.72
			144.88			38.82
			128.89			604.90

log 128.89 = 2.110220
log 604.90 = 2.781684

9.328536 = cot 77° 58′

log 604.90 = 2.781684
sin 77° 58′ = 9.990351

2.791333 = log 618.49

Missing course = S 77° 58′ E 618.49

Sec. tie N 77° 58′ W 618.49 feet

For the conflicting claim, Sur. No. 16591, the missing courses (the side and end lines) of the line actually traversed show us that the claim is surveyed and described correctly, with an error of not more than 1 foot in 2,000.

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
1—16591—No. 5.....	S. 29° 39′ E.	217.9	.....	189.35	107.78	.....
No. 5—No. 4.....	S. 14° 46′ W.	474.8	.....	459.11	.....	121.01
No. 4—No. 6.....	S. 4° 2′ W.	703.3	.....	701.55	.....	49.46
No. 6—4—16591	S. 58° 19′ W.	240	.....	126.05	.....	204.23
Cor. 4—1	N. 10° 15′ E.	1500	1476.06	.....	266.92	.....
			1476.06	1476.06	374.70	374.70

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
2—16591—No. 5.....	S. 54° 3′ W.	231.5	.....	135.91	.....	187.40
No. 5—No. 4.....	S. 14° 46′ W.	474.8	.....	459.11	.....	121.01
No. 4—No. 6.....	S. 4° 2′ W.	703.3	.....	701.55	.....	49.46
No. 6—Cor. 3.....	S. 26° 53′ E.	201.17	.....	179.42	90.95	.....
3—2	N. 10° 15′ E.	1500	1476.06	.....	266.92	.....
			1476.06	1475.99	357.87	357.87

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
1-16591—No. 5	S. 29° 39′ E.	217.9	.....	189.35	107.78	.....
No. 5—2-16591	N. 54° 3′ E.	231.54	135.91	.....	187.42	.....
2-16591—1-16591	N. 79° 45′ W.	300.00	53.38	.....	.....	295.21
			189.29	189.35	295.20	295.21

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
3-16591—No. 6	N. 26° 53' W.	201.2	179.45	.....	.....	90.97
No. 6—4-16591	S. 58° 19' W.	240.00	.....	126.05	.....	204.23
4-16591—3-16591	S. 79° 45' E.	300.00	.....	53.38	295.21	.....
			179.45	179.43	295.21	295.20

Conflict With Sur. No. 16591.

We are now in a position to figure the tie from Cor. No. 1, Sur. No. 17846, to Cor. No. 1, Sur. No. 16591, by missing course as follows:

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
1-178464—No. 1	S. 15° E.	150.00	.....	144.88	38.82	.....
No. 1—No. 4	N. 75° E.	335.6	86.86	.....	324.15	.....
No. 4—No. 5	N. 14° 46' E.	474.8	459.11	.....	121.01	.....
No. 5—1-16591	N. 29° 39' W.	217.9	189.35	.....	.....	107.78
			735.32	144.88	483.98	107.78
			144.88		107.78	
			590.44		376.20	

log 590.44 = 2.771176 log 590.44 = 2.771176
log 376.20 = 2.575419 log cos 32° 31' = 9.926029

cot 32° 31' = 0.195757 log 700.08 = 2.845147

Tie N 32° 30' E 700.08 feet.

32° 30'	700.	590.37	376.11
	.08	.06	.04
To check		590.43	376.15

We now figure the triangle a b c in which we have the course and length of a b given, namely, N 32° 30' E 700.08 feet. Subtracting courses to find angles, we get:

a=32° 30'	b=75° 00'	c= 10° 15'	a= 22° 15'
10° 15'	32° 30'	90° 00'	b= 42° 30'
		15° 00' = (90°—75°)	c=115° 15'
22° 15'	42° 30'		
		115° 15'	180° 00'

sin 115° 15' : 700.08 = sin 22° 15' : ?
sin 115° 15' : 700.08 = sin 42° 30' : ?

log 700.08	= 2.845147	log 700.08	= 2.845147
log sin 22° 15′	= 9.578236	log sin 42° 30′	= 9.829683
colog sin 115° 15′	= 0.043613	colog sin 15° 15′	= 0.043613
log 293.08	= 2.466996	log 522.90	= 2.718443

The angle e of the right triangle d e c is known (79° 45′ + 75° = 154° 45′ . 180° — 154° 45′ = 25° 15′) to be 25° 15′. We know d e is 300 feet, the width of the claim, therefore 300 is multiplied by the tan e to get c d. The length of the line c e may be found by multiplying 300 by the nat secant of e, or 300 may be divided by the cos of 25° 15′.

nat tan 25° 15′ =	.47163	nat secant 25° 15′ =	1.105638
	300		300
	141.489		331.6914

log 300	= 2.477121
log cos 25° 15′	= 9.956387
log 331.69	= 2.520734

Here natural functions may be used with great advantage, as d e is, with rare exceptions, 150, 300 or 600 feet, the width of the claim. The natural tangent of e may then be rapidly multiplied by 300 or 600 and in case of 150, quickly halved, and the half added to the tangent and multiplied by 100. The secant is treated in the same way.

The triangle l n c is, of course, equal to the triangle d e c.

By subtracting 141.49 from 522.90 we get 381.41, the length of the line from Cor. No. 2, Sur. No. 16591, to the intersection of line 1-4, Sur. No. 17846. All the sides of the parallelogram c e h n are, of course, of equal length and 331.69 feet. We therefore have n and h 854.59 and 713.10 feet, respectively, distant from Cors. Nos. 1 and 2, Sur. No. 16591. By subtracting these distances from 1500, we get the respective distances from Cors. Nos. 4 and 3.

The distances of e and h from Cors. Nos. 1 and 2 of Sur. No. 17846 are found in the same way.

293.08 293.08
141.49 331.69

151.59 624.77 = distance to e
331.69

483.28 = distance to h

The area of the parallelogram c e h n is found by multiplying 331.69 by 300, the width of the claim, and dividing by 43560, the number of square feet in an acre.

log 331.69	=	2.520734	log 331.69	=	2.520734
log 300	=	2.477121	log 300	=	2.477121
colog 43560	=	—5.360912			4.997855
log 2.284 acres	=	0.358767	log 43560	=	4.639088
			log 2.284 acres	=	0.358767

The process is somewhat simplified by adding the colog as given above.

Conflict With Sur. No. 17541.

In the case of Sur. No. 17541 we find Cors. Nos. 1 and 2, but not Cors. Nos. 3 and 4. The line 1-2 is found by our survey to be correct and Cors. Nos. 3 and 4 are then placed S 26° E 1,500 feet away as given in the notes of the survey for patent of Sur. No. 17541. We then figure the tie from Cor. No. 2, Sur. No. 17846, to Cor. No. 1, Sur. No. 17541.

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
2-17846—No. 1	N. 15° W.	150.00	144.88	.....	.....	38.82
No. 1—No. 4.....	N. 75° E.	335.6	86.86	.....	324.15	.....
No. 4—1-17541	S. 50° 16' E.	87.4	.....	55.86	67.21	.....
			231.74	55.86	391.36	38.82
			55.86		38.82	
			175.88		352.54	

log 175.88 = 2.245242
log 352.54 = 2.547208

log cot 63° 29′ = 9.698034

log 352.54 = 2.547208
log sin 63° 29′ = 9.951728

log 393.98 = 2.595480

Tie N 63° 29′ E 393.98 feet.

63° 29′

300.	= 133.94	268.44
93.	= 41.52	83.22
.98	= .44	.88
To check	175.90	352.54

We now figure the triangle j i k:

j=63° 29′	i=75°	k= 26°	180°	j= 89° 29′
26°	63° 29′	75°	101°	i= 11° 31′
				k= 79°
89° 29′	11° 31′	101°	79°	180° 00′

sin 79° 00′ : 393.98 = sin 11° 31′ : ?
sin 79° 00′ : 393.98 = sin 89° 29′ : ?

log 393.98 = 2.595480
log sin 11° 31′ = 9.300276
colog sin 79° 00′ = 0.008053

log 80.13 = 1.903809

log 393.98 = 2.595480
log sin 89° 29′ = 9.999982
colog sin 79° 00′ = 0.008053

log 401.34 = 2.603515

Then for the triangle p k o′ we have the angle k=11° (75° — 64° = 11°) and as it is a right triangle, we work it as in the case of the triangle d e c given above.

nat tan 11° = .19438
300

58.314

nat sec 11° = 1.0187
300

305.6100

log 300 = 2.477121
log cos 11° = 9.991947

log 305.61 = 2.485174

With 80.13 from above and 138.44 (58.31+80.13) we

have the two parallel sides of the trapezoid j k p o, and the area is found as follows:

138.44	log 109.28	=	2.038541
80.13	log 300.	=	2.477121
	colog 43560	=	—5.360912
2) 218.57			
	log .7526	=	—1.876574
109.28			

log 109.28 = 2.038541
log 300. = 2.477121

4.515662
log 43560 = 4.639088

log .7526 = 1.876574

To get the net area of the conflict between Sur. No. 17846 and Sur. No. 17541, that is, exclusive of the conflict between Sur. No. 17846 and Sur. No. 16591, we must figure the quadrilateral j k h r. From previous figuring we have the distance from Cor. No. 2, Sur. No. 17846, to k and h, respectively, and by subtracting, we thus get k h to be 81.94 feet (483.28—401.34). From this we may figure the quadrilateral in two ways, either as two triangles or by prolonging it to k', and figuring the triangle j k' r.

The easiest way to figure j h is by missing course as follows:

Station.	Course.		Dist.	N.Lat	S.Lat.	E. D'p	W. D'p
j—k	S. 26°	E.	80.13	.....	72.02	35.13	.....
k—h	N. 75°	E.	81.94	21.21	.....	79.16	.....
				21.21	72.02	114.29	
					21.21		
					50.81		

log 50.81 = 1.705949
log 114.29 = 2.058007

log cot 66° 2' = 9.647942

log 114.29 = 2.058007
log sin 66° 2' = 9.960843

log 125.07 = 2.097164

Course N 66° 2′ W 125.07 feet.

66° 2′	100.	= 40.62	91.38
	25.	= 10.15	22.84
	.07	= .03	.06
To check		50.80	114.28

We find the area of j k h as follows:

j=66° 2′	k= 26°	h= 66° 2′	180°	j= 40° 2′
26°	75°	75°	141° 2′	h= 38° 58′
				k=101° 00′
40° 2′	101°	141° 2′	38° 58′	180° 00′

Area = K = ½ (125.07 × 80.13 × sin 40° 2′).

log 125.07	=	2.097164	log 125.07	=	2.097164
log 80.13	=	1.903795	log 80.13	=	1.903795
log sin 40° 2′	=	9.808368	log sin 40° 2′	=	9.808368
colog 87120	=	—5.059882			
					3.809327
log .0739	=	—2.869209	log 43560	=	4.639088
			log .1479	=	—1.170239
			2) .1479		
			.0739 acres		

Here it is more convenient to add the colog of 87120 (43560 × 2) in place of dividing by 43560 and afterwards by 2.

In the triangle j h r the area is found to be:

j= 64°	180°	h=10° 15′	r=64°	j= 49° 58′
66° 2′	130° 2′	66° 2′	10° 15′	h= 76° 17′
				r= 53° 45′
130° 2′	49° 58′	76° 17′	53° 45′	180° 00′

$$\text{Area} = K = \tfrac{1}{2}\left(\frac{(125.07)^2 \times \sin 76° 17' \times \sin 49° 58'}{\sin 53° 45'}\right)$$

log 125.07	= 2.097164	log 125.07	= 2.097164
log to square	= 2.097164	log to square	= 2.097164
log sin 76° 17′	= 9.987434	log sin 76° 17′	= 9.987434
log sin 49° 58′	= 9.884042	log sin 49° 58′	= 9.884042
colog sin 53° 45′	= 0.093425		
colog 87120	= —5.059882		4.065804
		log sin 53° 45′	= 9.906575
log .1656	= —1.219111		
			4.159229
		log 43560	= 4.639088
		log .3313	= —1.52014

2) .3313

.1656 acres
.0739 acres

Total area j k h r = .2395 acres

Another way of calculating the quadrilateral j k h r is as follows: We first figure the triangle k k′ h in which, as we have seen above, we have k h = 81.94.

k= 75°	180°	k′=10° 15′	h=75°	k = 79°
26°	101°	26°	10° 15′	k′= 36° 15′
				h = 64° 45′
101°	79°	36° 15′	64° 45′	180° 00′

sin 36° 15′ : 81.94 = sin 64° 45′ : ?

$$\text{Area} = K = \tfrac{1}{2}\left(\frac{(81.94)^2 \times \sin 79° \times \sin 64° 45'}{\sin 36° 15'}\right)$$

log 81.94	= 1.913496
log to square	= 1.913496
log sin 79°	= 9.991947
log sin 64° 45′	= 9.956387
colog sin 36° 15′	= 0.228185
colog 87120	= —5.059882
log .115	= —1.063393

.115 = area k k′ h

log 81.94 = 1.913496
log sin 64° 45′ = 9.956387
colog sin 36° 15′ = 0.228185

log 125.35 = 2.098068

jk = 80.13
kk′ = 125.35

jk′ = 205.48

For the triangle j k′ r we thus have the base from which we figure the area.

log 205.48 = 2.312769
log tan 36° 15′ = 9.865240
log 205.48 = 2.312769
colog 87120 = —5.059882

log .355 = —1.550660

area jk′r = .355 acres
area kk′h = .115 acres

area jkhr = .240 acres

This result checks the first method and gives another method which frequently has to be used.

Conflict With Sur. No. 12716.

Taking next our conflict with Sur. No. 12716, we figure the missing course from Cor. No. 4, Sur. No. 17846, to Cor. No. 2, Sur. No. 12716, using our tie made on the ground from No. 8. We assume that we have found the boundaries of Sur. No. 12716 to be correct.

Station.	Course.	Dist.	N.Lat	S.Lat.	E.D'p	W.D'p
4-17846—No. 9	S. 15° E.	150.00	.....	144.88	38.82	.....
No. 9—No. 8.....	S. 75° W.	458.00	.....	118.54	.....	442.39
No. 8—2-12716	N. 40° 32′ W.	62.3	47.35	.....	.....	40.48
			47.35	263.42	38.82	482.87
				47.35		38.82
				216.07		444.05

log 216.07 = 2.334595
log 444.05 = 2.647432

log cot 64° 03′ = 9.687163

log 444.05 = 2.647432
log sin 64° 03′ = 9.953845

log 493.84 = 2.693587

Course S 64° 03′ W 493.84 feet.

64° 03′		
400	= 175.04	359.67
93	= 40.69	83.62
.84	= .36	.75
To check	216.09	444.04

The triangles w x z and w x y may be worked at the same time and the triangle y z x afterwards calculated as a check and for area.

w=75°	x=64° 03′	y= 51°	w= 10° 57′
64° 03′	51°	90°	x= 13° 03′
10° 57′	13° 03′	15° (90°—75°)	y=156°
		156°	180° 00′
	z= 75° 180°	x= 64° 03′	w= 10° 57′
	39° 114°	39°	z= 66°
	114° 66°	103° 03′	x=103° 03′
			180° 00′

sin 156° : 493.84 = sin 10° 57′ : ?
sin 156° : 493.84 = sin 13° 03′ : ?

sin 66° : 493.84 = sin 10° 57′ : ?
sin 66° : 493.84 = sin 103° 03′ : ?

log 493.84	= 2.693587	log 493.84	= 2.693587
log sin 10° 57′	= 9.278644	log sin 13° 03′	= 9.353726
colog sin 156°	= 0.390687	colog sin 156°	= 0.390687
log 230.63	= 2.362918	log 274.16	= 2.438000

log 493.84	= 2.693587	log 493.84	= 2.693587
log sin 10° 57′	= 9.278644	log sin 103° 03′	= 9.988636
colog sin 66°	= 0.039270	colog sin 66°	= 0.039270
log 102.68	= 2.011501	log 526.61	= 2.721493

In the right triangle y z x we have from above z x = 102.68.

log 102.68	= 2.011501	log 102.68	= 2.011501
log tan 66°	= 10.351417	log cos 66°	= 9.609313
log 230.63	= 2.362918	log 252.47	= 2.402188

log 102.68	= 2.011501
log 230.63	= 2.362918
colog 87120	= —5.059882
log .2718	= —1.434301

274.16
252.47
526.63 To check

.2718 = area y z x

Conflict With Sur. No. 1462.

In the case of the conflict with Sur. No. 1462, no corners, bearing trees, or bearing rocks could be found, neither could the discovery shaft be identified. The conflict, therefore, must be figured according to its patented or descriptive position and from its section tie. This patented position of Sur. No. 1462 may or may not be its true position, depending on the accuracy of the section tie. In this case a traverse is made from Cor. No. 1, Sur. No. 1462, to section corner (by means of its section tie), thence by section tie to Cor. No. 1, Sur. No. 17846, thence along lines 1-4 and 4-3, Sur. No. 17846, thence by missing course to Cor. No. 1, Sur. No. 1462.

Station.	Course.	Dist.	N.Lat	S.Lat.	E.D'p	W.D'p
1-1462—Sec. Cor.	N. 87° 14′ W.	2006.4	96.85	.....	.....	2004.06
Sec. Cor.—1-17846	S. 77° 58′ E.	618.49	.....	128.89	604.90	.....
1—2-17846	N. 75° E.	1500.00	388.23	.....	1448.85	.....
2—3-17846	S. 15° E.	300.00	.....	289.78	77.64	.....
			485.08	418.67	2131.39	2004.06
			418.67		2004.06	
			66.41		127.33	

log 66.41	= 1.822233	log 127.33	= 2.104928
log 127.33	= 2.104928	log sin 62° 27′	= 9.947731
log cot 62° 27′	= 9.717305	log 143.61	= 2.157197

Course S. 62° 27′ W. 143.61 feet.

62° 27′

100.	= 46.25	88.66
43.	= 19.89	38.12
.61	= .28	.54
To check	66.42	127.32

From this the triangles u s t and v s t are figured.

v=32°	s=62° 27′	t=15°	180°	v= 47°
15°	32° 00′	62° 27′	77° 27′	s= 30° 27′
47°	30° 27′	77° 27′	102° 33′	t=102° 33′
				180° 00′

u=75°	180°	t=75°	u=137°
32°	43°	62° 27′	t= 12° 33′
43°	137°	12° 33′	s= 30° 27′
			180° 00′

sin 137° : 143.61 = sin 30° 27′ : ?
sin 137° : 143.61 = sin 12° 33′ : ?

sin 47° : 143.61 = sin 102° 33′ : ?
sin 47° : 143.61 = sin 30° 27′ : ?

log 143.61	= 2.157197	log 143.61	= 2.157197
log sin 30° 27′	= 9.704825	log sin 12° 33′	= 9.337043
colog sin 137°	= 0.166217	colog sin 137°	= 0.166217
log 106.74	= 2.028239	log 45.76	= 1.660457
log 143.61	= 2.157197	log 143.61	= 2.157197
log sin 102° 33′	= 9.989497	log sin 30° 27′	= 9.704825
colog sin 47°	= 0.135873	colog sin 47°	= 0.135873
log 191.67	= 2.282567	log 99.52	= 1.997895

In triangle u t v we have:

log 106.74	= 2.028239	log 106.74	= 2.028239
log tan 43°	= 9.969656	log cos 43°	= 9.864127
log 99.52	= 1.997895	log 145.92	= 2.164112

log 106.74 = 2.028239
log 99.52 = 1.997895
colog 87120 = —5.059882
log .1219 = —1.086016

To check 145.92 = uv
45.76 = su
191.68 = sv

.1219 acres = area triangle u t v

Conflict With Sur. No. 17560.

For Sur. No. 17560 we first find the course and distance from Cor. No. 3, Sur. No. 17846, to Cor. No. 4, Sur. No. 17560, as follows:

Station.	Course.	Dist.	N. Lat	S. Lat.	E. D'p	W. D'p
4-17560—No. 8	N. 45° 10′ W.	149.5	105.40	.....	.....	106.02
No. 8—No. 9.....	N. 75° E.	458.0	118.55	.....	442.39	.....
No. 9—3-17560	S. 15° E.	150.00	.....	144.88	38.82	.....
			223.95	144.88	481.21	106.02
			144.88		106.02	
			79.07		375.19	

log 79.07 = 1.898012
log 375.19 = 2.574251
log cot 78° 06′ = 9.323761

log 375.19 = 2.574251
log sin 78° 06′ = 9.990565
log 383.43 = 2.583686

S 78° 6′ W 383.43 = course

78° 6′		
300.	= 61.86	293.55
83.	= 17.11	81.21
.43	= .08	.42
	79.05	375.18

For the triangle A B t

A=75° 00′	B=180° 00′	t=78° 06′	A= 40° 52′
34° 08′	78° 06′	75° 00′	B=136° 02′
40° 52′	101° 54′	3° 06′	t= 3° 06′
	34° 8′		180° 00′
	136° 02′		

sin 40° 52′ : 383.43 = sin 136° 02′ : ?
sin 40° 52′ : 383.43 = sin 3° 06′ : ?

log	383.43 = 2,583686	log	383.43 = 2.583686
log sin	136° 02′ = 9.841509	log sin	3° 06′ = 8.733027
colog sin	40° 52′ = 0.184222	colog sin	40° 52′ = 0.184222
log	406.83 = 2.609417	log	31.69 = 1.500935

For the triangle D A E:

D=	75° 00′	180° 00′	A=75° 00′	E=34° 08′	
	75° 45′	150° 45′	34° 08′	75° 45′	
	150° 45′	29° 15′	40° 52′	109° 53′	

318.98=E B
31.69=B A
287.29=E A

D= 29° 15′
A= 40° 52′
E=109° 53′
180° 00′

sin 29° 15′ : 287.29 = sin 109° 53′ : ?
sin 29° 15′ : 287.29 = sin 40° 52′ : ?

log	287.29=2.458320	log	287.29=2.458320
log sin	109° 53′=9.973307	log sin	40° 52′=9.815778
colog sin	29° 15′=0.311028	colog sin	29° 15′=0.311028
log	552.91=2.742655	log	384.70=2.585126

In order to ascertain the intersection of line 6-1-Sur No. 17560 and line 4-1-Sur No. 17846, prolong line 6-1-Sur No. 17560 with dotted lines until it touches line 2-3-Sur No. 17846. Thus we have the triangle G D F of which we have the side G D as follows:

500.00=5-6-17560.
384.70=D E
115.30=G D

G=	75° 45′	D= 75° 45′	180° 00′	F= 75° 00′	G= 39° 45′	
	36° 00′	75° 00′	150° 45′	36° 00′	D= 29° 15′	
	39° 45′	150° 45′	29° 15′	111° 00′	F=111° 00′	
					180° 00′	

sin 111° : 115.30 = sin 39° 45′ : ?
sin 111° : 115.30 = sin 29° 15′ : ?

log	115.30=2.061829	log	115.30=2.061829
log sin	39° 45′=9.805799	log sin	29° 15′=9.688972
colog sin	111°=0.029848	colog sin	111°=0.029848
log	78.97=1.897476	log	60.35=1.780649

In the right triangle J F H 36°—15°=21°, J H=300 ft.,

nat. tan. 21°=0.38386	nat. secant 21°=1.071145
300	300
115.158	321.3435

321.34=J F
60.35=G F

260.99=J G=cor. No. 6-17560 to line 4-1-17846.

In figuring the triangle A B t we find cor. No. 2-17846 to A=1500
406.84=At

1093.17=2-17648—A

From cor. No. 2-17846 to D we have:

1093.17=2-17648-A
552.91=D A

540.26=2-17648-D

In the triangle G D F we find F D, and in the triangle J H F we find H F

FD= 78.97	cor. No. 2-17846 to D=540.26
HF=115.15	HD=194.12
HD=194.12	cor. No. 2-17846-H=346.14=
	cor. No. 1-17846 to line 6-1-17560.

In the triangle J K L line J K is drawn parallel to line 1-2-17560.

J= 75° 00′	K= 34° 08′	L= 36° 00′	180°	J= 40° 52′
34° 08′	36° 00′	75° 00′	111°	K= 70° 08′
				L=69° 00′
40° 52′	70° 08′	111° 00′	69°	
				180° 00′

sin 69° : 318.98 = sin 40° 52′ : ?
sin 69° : 318.98 = sin 70° 08′ : ?

log	318.98=2.503764	log	318.98=2.503764
log sin	40° 52′=9.815778	log sin	70° 08′=9.973352
colog sin	69°=0.029848	colog sin	69°=0.029848
log	223.55=2.349390	log	321.34=2.506964

1000.00=6-1-Sur. No. 17560
260.99=J G

739.01=1-Sur. No. 17560 to 1-4-Sur. No. 17846.
223.55=K L

962.56=2-Sur. No. 17560 to 1-4-Sur. No. 17846.

346.14=1-Sur. No. 17846 to line 6-1-Sur No. 17560.
321.34=J L

667.48=1-Sur. No. 17846 to line 2-3 Sur. No. 17560.

1000
962.56

37.44=3-Sur. No. 17560-line 4-1- Sur. No. 17846.

Areas of Sur. No. 17560.

We first figure the area of the trapezoid J L 3 6 and the parallelogram represented by cors. Nos. 3, 4, 5 and 6 of Sur. No. 17560.

260.99=J 6
37.44=L 3

2) 298.43

149.21

log	149.21=	2.173798
log	300=	2.477121
colog	43560=	—5.360912
log	**1.027=**	**0.011831**

500
300

150000 = 5.176091
colog 43560=—5.360912

log 3.443= 0.537003

Area for the triangle D A E

log 552.91= 2.742655
log 287.29= 2.458320
log sin 40° 52′= 9.815778
colog 87120=—5.059882

log 1.193= 0.076635

1.027
3.443

4.470
1.193

3.277=Total area in conflict between Surs. Nos 17846 and 17560.

To find the area in conflict between Sur. No. 16591 and Sur. No. 17560 within Sur. No. 17846, we figure the area of the triangle J e N.

J= 75° 180°
36° 111°

111° 69°

e=75° 00′
10° 15′

64° 45′

N=36° 00′
10° 15′

46° 15′

J=69°
e=64° 45′
N=46° 15′

180° 00′

624.77=1-Sur. No. 17846—2-3-16591
346.14=1-Sur. No. 17846—6-1-17560.

278.63=J e

sin 46° 15′ : 278.63 = sin 64° 45′ : ?

log 278.63=2.445028
log sin 64° 45′=9.956387
colog sin 46° 15′=0.141244

log 348.87=2.542659

log 278.63=2.445028
log sin 69°=9.970151
log 348.87=2.542659
colog 87120=5.059882

log 1.041=0.017720

In the triangle G N M

348.87=J N
260.99=J G

87.88=G N

G=75° 45′
36° 00′

39° 45′

N=36° 00′
10° 15′

46° 15′

M=75° 45′
10° 15′

86° 00′

G= 39° 45′	
N= 46° 15′	180°
M= 94° 00′	86°
180° 00′	94°

$$\text{Area} = \tfrac{1}{2}\left(\frac{(87.88)^2 \times \sin 39° 45' \times \sin 46° 15'}{\sin 94°}\right)$$

log	87.88=	1.943890	
log to square	=	1.943890	1.041=area J e N.
log sin	39° 45′=	9.805799	.041=area G M N.
log sin	46° 15′=	9.858756	
colog sin	94°=	0.001059	1.000=net area in conflict
colog	87120=—	5.059882	of Surs. Nos. 17560 and 16591 within Sur. No.
log	.0410=—	2.613276	17846.

We now figure the area in conflict of Sur. No. 17560 and sur. No. 17541 within Sur. No. 17846 which is Q o p D G.

By previous work we have found the total conflict of Sur. No. 17541 and Sur. No. 17846 to be .752 acres. We have also found the area of the quadrilateral j r h k to be .240 acres. We must now find the area of Q r M G. In order to figure the area of the triangle Q r N it is necessary to find the length of one side, which we will take r N. In previous figuring the area of the triangle j r h was obtained and from the data used in that work we find the side r h as follows:

j= 64° 00′	180° 00′	r=64° 00′	h=10° 15′
66° 02′	130° 02′	10° 15′	66° 02′
130° 02′	49° 58′	53° 45′	76° 17′

sin 53° 45′ : 125.07 = sin 49° 58′ : ?

log	125.07=2.097164	j=49° 58′
log sin	49° 58′=9.884042	r=53° 45′
colog sin	53° 45′=0.093425	h=76° 17′
log	118.75=2.074631	180° 00′

In the small triangle F h N we must obtain the side h N. We have the side F h as follows:

483.29=2-Sur. No. 17846 to line 2-3 Sur. No. 16591.
461.29=2 Sur. No. 17846 to F.

22.00=F h.

				F=69° 00′
F= 75°	180°	h=75° 00′	N=36° 00′	h=64° 45′
36°	111°	10° 15′	10° 15′	N=46° 15′
111°	69°	64° 45′	46° 15′	180° 00′

Sin 46° 15′ : 22.00 = Sin 69° : ?

		N h= 28.44
log	22.00=1.342423	h r=118.75
log sin	69°=9.970152	
colog sin 46° 15′	=0.141244	r N=147.19
log	28.44=1.453819	

r=64° 00′	N=10° 15′	Q= 64°	180°	r= 53° 45
10° 15′	36° 00′	36°	100°	N= 46° 15′
53° 45′	46° 15′	100°	80°	Q= 80° 00′
				180° 00′

$$\text{Area triangle Q r N} = \tfrac{1}{2}\left(\frac{(147.19)^2 \times \sin 53^\circ\ 45' \times \sin 46^\circ\ 15'}{\text{Sin } 80^\circ\ 00'}\right)$$

log	147.19=	2.167878
log to square	=	2.167878
log sin	53° 45′=	9.906575
log sin	46° 15′=	9.858756
colog sin	80°=	—0.006649
colog	87120=	—5.059882
log	.1471=	—1.167618

Subtracting from this the area of triangle G M N found in previous work to be .0410 acres, we have:

.1471
.0410

.1061 acres=Q r M G

In the small triangle h M D we have h D=
540.26=2-17846 to D
483.29=2-17846 to h

56.97=h D

h=75° 00′	M=75° 45′	D= 75° 45′	180° 00′
10° 15′	10° 15′	75° 00′	150° 45′
64° 45′	86° 00′	150° 45′	29° 15′

h=64° 45′
M=86° 00′
D=29° 15′

180° 00′

$$\text{Area}=\tfrac{1}{2}\left(\frac{(56.97)^2\times\sin 64^\circ 45'\times\sin 29^\circ 15'}{\text{Sin } 86^\circ}\right)$$

			.752=area j k o p
log	56.97=	1.755646	.240=area j r h k
log to	square =	1.755646	
sin	64° 45′ =	9.956387	.512=area r h o p
sin	29° 15=	9.688972	.016=area h M D
colog sin	86°=	0.001059	
colog	87120=—	5.059882	.496=area r o p D M
			.106=area Q r M G
log	.0165=—	2.217592	
			.602=area Q o p D G

We therefore have found the total area in conflict of Sur. No. 17846 and Sur. No. 17560 to be 3.277 acres.

The net area in conflict of Surs. Nos. 17560 and 16591 within Sur. No. 17648 to be 1.000 acres.

The total conflict of Surs. Nos. 17560 and 17541 within Sur. No. 17846 to be .602 acres, and the net conflict of Surs. Nos. 17560 and 17541, within Sur. No. 17846, (that is, exclusive of Q r M G, .106 acres) to be .496 acres.

Therefore the net conflict of Surs. Nos. 17560 and 17846 is:

1.000 acres=J e M G	3.277 acres
.496 acres=r o p D M	1.496 acres
1.496 acres	1.781 acres, net conflict.

This result may be checked by Double Meridian Dis tances as follows:

Station.	Course.	Distance.	Latitudes N.	Latitudes S.	Departures E.	Departures W.	Double M. D.	N. Areas	S. Areas
B-A	S34° 08'W	31.69		26.23		17.78	17.78		466.37
A-p	S75° 00'W	336.22		99.96		373.06	408.62		40845.55
p-o	N26° 00'W	138.44	124.43			60.68	842.36	104814.08	
o-r	S64° 00'W	149.33		65.47		134.23	1037.27		67910.06
r-e	N10° 15'E	212.94	209.54		37.89		1133.61	237536.56	
e-L	N75° 00'E	42.71	11.05		41.25		1054.47	11651.90	
L-3	S36° 00'E	37.44		30.29	22.00		991.22		30024.05
3-B	S75° 45'E	500.00		123.07	484.61		484.61		59641.00
			345.02	345.02	585.75	585.75		354002.54	198887.13
								198887.13	
								2) 155115.41	
								77557.7 sq. ft.	

log 77557.7=5.8896249
log 43560 =4.6390879

log 1.780=1.2505370

The area statement for Sur. No. 17846 would be as follows:

Total area Sur. No. 17846		10.330 acres
Area in conflict with		
Sur. No. 1462	.122	"
Sur. No. 12716	.272	"
Sur. No. 16591	2.284	"
Sur. No. 17541	.752	"
Sur. No. 17541 (exclusive of its conflict with Sur. No. 16591)	.513	"
Sur. No. 17560	3.277	"
Sur. No. 17560 (exclusive of its conflict with Sur. No. 16591)	2.277	"
Sur. No. 17560 (exclusive of its conflict with Sur. No. 17541)	2.675	"
Sur. No. 17560 (exclusive of its conflict with Surs. Nos. 16591 and 17541)	1.781	"
Total area Sur. No. 17846		10.330 "
Less area in conflict with		
Sur. No. 1462	.122 acres	
Sur. No. 12716	.272 "	
Sur. No. 16591	2.284 "	
Sur. No. 17541	.513 "	
Sur. No. 17560	1.781 "	= 4.972 "
Net area lode claim		5.358 "

In case of an irregular mill site or placer the calculations of the area by double meridian distances must be handed in with the field notes. The calculations have been taken up under mill sites and placers.

It is well to be systematic in making and filing the above calculations. Many prefer books of uniform size, but here it is very difficult for more than one person to work on the same case at the same time and keep the calculations together in the same book. It is also difficult to copy from one page to another as is often necessary. The writer prefers to use traverse blanks printed and blocked. On these the traverse is first worked and the triangles and areas figured underneath on the same sheet. These sheets are then filed in Congress manilla envelopes in document files.

In this way any number of people may work on the same case without getting into each other's way. The papers of each survey are kept together in order, and all useless figuring and any calculations found to be in error are destroyed and do not encumber the record.

Miscellaneous on Patents.

Various points may arise in figuring or writing up the notes that need attention. For example, it frequently happens that by excluding areas in the usual way a discovery shaft is excluded. To avoid this, a tract is made around the discovery shaft, and one corner of the tract is tied to a corner of the claim, and the tract described by metes and bounds. In Fig. 33, if either A or B excludes the other then

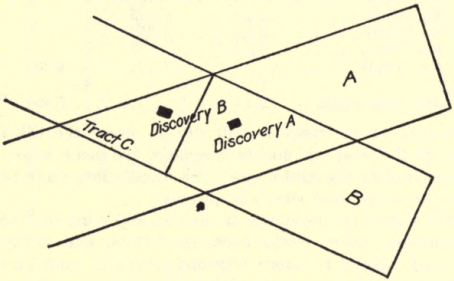


Fig. 33.

they respectively exclude their discovery shafts. To avoid this the conflict is described as follows:

Total area A lode	5.165	acres
Area in conflict with—		
Trace C (hereinafter described)	.310	"
B lode of this survey	.840	"
B lode of this survey (exclusive of its conflict, with tract C)	.530	"
Total area A lode	5.165	"
Less area in conflict with Tract C	.310	"
Net area A lode	4.855	acres

This tracting of the discovery is useful sometimes in conflict with a location survey. If A above is a location survey, a small tract, just large enough, may be made round the discovery shaft of B and not excluded with the re-remainder of the conflict of A with B. This small reservation, which may not be over ten feet square is usually not objected to by the owner of the location, and might even be deeded back to him after the patent is issued.

During the period that conflicts were figured in the descriptive positions by their section ties as stated before, tracts were frequently employed to exclude the conflicting claim or claims in their true positions. Thus when figuring the position from the section ties showed no conflict, but the corners on the ground clearly showed a conflict, this was excluded as a tract. Tracts are frequently employed to exclude any desired area other than that embraced in an officially surveyed claim.

In case the discovery is unavoidably excluded the claim may still be patented according to the present rulings of the general land office by producing proofs that there is a valid discovery of mineral at some other point on the center line not excluded.

Here it may be observed that for about five years between June, 1899, and August, 1904, the general land office required all claims to be figured according to their patented positions, as we have figured Sur. No. 1462, regardless of the existence or position of the monuments on the ground.

As the section ties of many claims varied from a few feet to many thousand feet from the correct distance, the official plats issued during the period mentioned above, often give a very erroneous idea of the conditions actually existing on the ground. The surveyor dealing with claims surveyed within the time mentioned must bear clearly in mind the conditions under which the surveys were made.

In case errors are found in the surveying and description of conflicts, the conflicting claim must be platted and figured as actually found on the ground, and a note added to the field notes filed with the surveyor's general office about as follows:

I find the following errors in the lines of former approved surveys:

Sur. No. 16162, Alice Lode:

Line 1-2, S16° 10'W 147.8 ft. instead of S16° 50'W 150 ft., as approved.

Line 2-3, S73° 50'W 1506 ft. instead of S73° 10'W 1500 ft., as approved, etc.

The deputy who made the conflicting survey which is found to be in error then files amended notes covering the errors in question. In case he does not admit that there is an error, a joint survey is called for at the expense of the one who is found to be wrong.

Deputy surveyors, however, rarely require an official joint survey to settle their differences, and disagreements are as a rule arranged privately and the reports made in accordance with the facts. Here it must be remembered that an error of one in two thousand or about two minutes in course is allowed by the surveyor general. Thus it is evident that two surveyors may differ from each other one in one thousand or three minutes in course and yet be within the limit of allowable error.

All the intersections and areas having been figured for the claim, a plat is made on tracing cloth, the dull side, and the notes are written up as in the example of field notes given later.

In case the claim has been narrowed on one side and the vein and therefore the discovery is not in the center of the claim, a tie must be given to it from some corner of the survey.

Claims are frequently cut short when on account of conflicts no acreage is obtained by patenting the full length. This of course often reduces the amount of figuring necessary, but it is sometimes objected to by the claimant as he frequently thinks it desirable to be able to state that he has a claim 1500 feet long even if it gives him no more acreage than if the claim were only 800 feet in length and on clear ground. It must here be remembered that during many years the general land office required all claims either to cross a conflicting claim completely with the center line, or else cut off the claim at the point where the center line intersected the boundary lines of the conflicting claim. In fact for a brief period no crossings at all were allowed by the general land office.

In case the claim has been cut off for any reason, a tie must be given in every case from the corner set to the original corner of the location.

It is sometimes advisable in very complicated cases to write up the notes in advance of the actual figuring, leaving blank spaces which are filled systematically as the calculations proceed. In this way repetitions and omissions are avoided.

In the matter of improvements, the so-called "$500 worth of work," the land office is constantly changing its opinion. For many years $500 worth of work sufficed for a whole group of locations, no matter how many, provided that the work was done for their common benefit. This was in accordance with a decision of the Supreme Court of the United States, which regarded a group of locations as one claim. At present $500 worth of work is required for each claim, though it need not necessarily be on each

claim. A tunnel can thus be used to patent a whole group, provided there is $500 worth of work which can be shown to be for the benefit of each location, or a total of as many dollars as there are locations in the group multiplied by $500. In case this mutual benefit cannot be shown for certain locations, other work must be in evidence. It cannot be too strongly stated that the utmost care must be taken by the deputy surveyor in preparing his mutual benefit statement to bring out strongly the fact of the mutual benefit of the improvements in the event that there is not actually $500 worth of work on each claim. Neglect of this has caused a great deal of trouble in the subsequent dealings with the general land office. When the claim being patented is contiguous to a patented claim belonging to the same claimant, work done on the patented claim may apply towards the $500 worth of improvements, provided the work has never been used in patenting any other claim, and also provided that it can be shown to be of benefit for the claim in question, and both these facts must be stated in the field notes. This can be done only when the claims are contiguous, and under the same ownership, or, when not contiguous, in the case of a tunnel, when the work is actually under the claims being patented.

All of the improvements need not be used in patenting if there is a possibility of their being used later on for other claims as five hundred dollars expenditure. Where there is a chance of this in the future it is well to claim only enough improvements necessary to patent the claim in question.

At the time the survey is approved the required $500 for each location may not have been completed, or it may happen that more improvements are required at a later date by the General Land Office. In this case the surveyor makes a supplementary affidavit of labor. This is made on a form furnished by the Surveyor's General Office, and the surveyor repeats or revises all the data given in the ap-

proved field notes, and then adds the description of the new work. He also states, as is required, that the work was completed before the period of advertising expired.

Should it be desired to take the whole or any portion of a piece of ground that has been surveyed and advertised for patent, though no patent has actually issued, it is usually necessary to have the application for this claim cancelled before the ground or any portion of it can be included in a later application.

The surveyor must be careful in the case of mill sites to see that it is clearly shown that they are used for mining purposes and not just to take up land or water. They may legitimately contain mills and reduction works, dumps, necessary roads, cabins, storehouses, etc., actually used in connection with mining operations, and the fact must in each case be clearly shown.

Mill sites will not be allowed at the present writing to touch the side line of any location in the same group in which they are being patented, nor can they be placed on the end of any claim. A slight space between in each of the above cases will probably avoid difficulty.

Adverses and Protests.

In surveys for adverse the claim adversing is tied to the official survey adversed exactly as described in previous sections, and the area in conflict figured in the same way. Improvements should be also noted as in patent surveys. The net area in conflict is then described by metes and bounds and this description had best be traversed carefully to make sure of a closure. An adverse plat is finally prepared usually on a scale of 200 feet to the inch on tracing cloth and the area in conflict colored. The deputy surveyor signs a statement as follows:

I hereby certify that the above diagram correctly represents the conflict claimed to exist between the Little Annie lode and the Belle lode as actually surveyed by me.

And I further certify that the value of the labor and improvements on the Little Annie lode made by the adverse claimant (and his grantors) is not less than one hundred dollars.

JOHN SMITH,
United States Deputy Mineral Surveyor.

When time is lacking to figure the conflict completely, the adverse plat with simply the ties and boundaries of the conflicting claims, and the improvements of the claim adversing may be filed and the complete description sent in later. In case it is impossible to make the adverse survey, as, for example, on account of deep snow, the best statement possible of the facts should be made at once and a proper survey made later. The attorney for the claimant prepares all the papers in an adverse suit, as well as in a protest suit, which latter, from the standpoint of the surveyor, is practically the same as an adverse suit, and the surveyor simply supplies him with the plat and the description of the conflict.

The deputy surveyor who is surveying claims for patent should avoid all possible cause for adverse or protest proceedings by leaving out all ground clearly belonging to others. In spite of his best efforts his claims will occasionally be adversed and his advice may be called for in connection with the settlement of the case, or he may be cited as a witness. Should the case be fought to a finish in the courts, he has no influence. In case of a compromise, by which the claimant patenting loses the area in conflict or any portion of it, the simplest solution is usually to deed this area to the contestant after the receiver's receipt is issued. In case the area is simply left out in the final application to purchase, the land office will call for an amended plat at some later date, with attendant delay and expense. This amended plat will be called for in any case where any area is excluded in the final application to purchase, and which is not shown in the field notes approved

by the Surveyor General. While this is all part of the attorney's work, and has really nothing to do with the actual surveying, it is well for the surveyor to keep in mind the probable subsequent actions of the General Land Office in order to provide for the best interests of his clients.

CHAPTER VI

Patent Field Notes.

The following is a set of field notes according to the present requirements of the General Land Office. (See plate III.)

(Application for Survey.)

Notice.

Applicants are requested to mention in one application the name or names of the locations constituting the entire claim of which they desire an official survey, and are advised that several locations can be embraced in a single survey only when the same are contiguous—i. e., such as conflict or adjoin. Therefore, to obviate confusion and delay, strictly observe the foregoing in filling applications for orders for surveys.

January 25th, 1893.

To the U. S. Surveyor-General,

District of Colorado, Denver.

Sir:

You are requested to issue an order for an official survey of the mining claim of **T. E. Jenkins et al** upon the **Cumro Placer, and Poorman, Hawley, Aetna, and Podunk lodes, and the Poorman mill site,** located in **Pike's Peak** Mining District, **El Paso** County, **Pueblo** Land District, Colorado.

I herewith transmit CERTIFIED copies of the Location Certificates of said claim, and have deposited for office fees on same, **$160.00** to the credit of the Treasurer of the United States at the **First** National Bank (U. S. Depository), with request that duplicate certificate be forwarded to you.

Send order to **A. L. Hawley,** U. S. Dep. Min. Sur., at **Denver,** Colorado.

Yours, respectfully,

T. E. JENKINS, et al.,
Claimants.

By JOHN SMITH,
Attorney.

P. O. Address, **Denver, Colo.**

(Order for Survey.)

DEPARTMENT OF THE INTERIOR,
Office of U. S. Surveyor General.

Denver, Colo., **February 6, 1893.**

To **A. L. Hawley, Esq.,**
U. S. Deputy Mineral Surveyor, District of Colorado.
Denver, Colo.,

Sir:

You are hereby directed to survey the claim of **T. E. Jenkins, et al.,** upon the **Cumro Placer, and Poorman, Hawley, Aetna, and Podunk lodes, and Poorman mill site,** in **Pike's Peak** Mining District, **El Paso** County, Colorado. This survey will be designated "Survey No. **8000 A and B, Pueblo** Land District," and must be made in strict conformity with the **locations.**

.....

U. S. Surveyor General for Colorado.

(Specimen Field Notes.)

(4—683.)

Mineral Survey No. 8000 A and B.

Lot No.....

.....

Pueblo Land District.

FIELD NOTES.

of the survey of the mining claim of

T. E. Jenkins et al.,

Cumro Placer and Poorman, Hawley, Aetna, and Podunk Lodes, and Poorman Mill Site, Pike's Peak Mining District, El Paso County, Colorado, Sections 17, 19, and 20, Township 14 S, Range 69 W. of the 6th P. M.

Surveyed under instructions dated **February 6th, 1893.**

By **A. L. HAWLEY,**

U. S. Deputy Mineral Surveyor.

Claim located....., 1

Survey commenced **February 9th, 1893.**

Survey completed **February 12th, 1893.**

Address of claimants:

Denver, Colorado.

Feet.	Survey No. 8000 A.
	Cumro Placer. Tract A.
	Beginning at Cor. No. 1. Identical with the S. W. Cor. of the location and with the S. W. Cor. of Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. A pine post, 4½ ft. long, 4 ins. square, set 2 ft. in the ground, with mound of stone, alongside the section corner, scribed 1-8000 A, whence A spruce, 17 ins. diam., bears N. 8° 41′ W. 7 ft., and a spruce, 14 ins. diam., bears S. 68° 14′ E. 18.5 ft., each blazed and scribed B. T. 1-8000 A. James Peak bears N. 52° 21′ W. Hahns Peak bears N. 29° 28′ W. Thence North (a). Va. 14° 22′ E.
660.	To Cor. No. 2. Identical with a corner of the location. A pine post, 4½ ft. long, 4 ins. square, set 18 ins. in the ground, with mound of earth and stone, scribed 2-8000 A, whence A spruce 18 ins. diam., blazed and scribed B. T. 2-8000 A, bears S. 14° 47′ E. 17.3 ft. Thence N. 89° 50′ E. (a) Va. 14° 28′ E.
182.3	To Cor. No. 3. On line 1-2 Hawley lode of this survey. A cedar post, 5 ft. long, 4 ins. square, set 2 ft. in the ground, with mound of earth, scribed 3-8000 A, whence A corner of the location bears N. 89° 50′ E. 1126.7 ft. No other bearings available. Thence S. 3° 48′ E. Va. 14° 28′ E.

(a).—Lines 1-2, 2-3, and 11-1, Tract A, 14-15 and 15-16 Tract B, and 19-20 and 20-17, Tract C, follow the subdivisional lines of the public survey, according to the official and approved field notes thereof.

Feet.	
84.5	To Cor. No. 4. A pine post, 4½ ft. long, 4 ins. square, set 2 ft. in the ground, with mound of stone, scribed 4-1-8000 A, whence A pine, 14 ins. diam., bears S. 21° 47′ E. 14.3 ft., and a spruce, 11 ins. diam., bears N. 14° 52′ E. 6 ft., each blazed and scribed B. T. 4-1-8000 A. Thence N. 86° 12′ E. Va. 14° 28′ E.
67.2	To Cor. No. 5. At intersection of lines 4-1 and 1-2, Hawley and Poorman lodes, respectively, both of this survey. A cottonwood post, 5 ft. long, 4 ins. square, set 2 ft. in the ground, with mound of stone, scribed 5-8000 A, whence No bearings available. Thence S. 17° 38′ W. Va. 14° 36′ E.
243.4	To Cor. No. 6. A pine post, 4½ ft. long, 4 ins. square, set 2 ft. in the ground, with mound of earth, scribed 6-1-8000 A, whence A high Mt. bears N. 51° 14′ E. Thence S. 41° 14′ E. Va. 14° 30′ E.
350.48	To Cor. No. 7. A granite bowlder, 27x12x9 ins., set 16 ins. in the ground, chiseled 7-6-8000 A, whence No bearings available. Thence N. 17° 38′ E. Va. 14° 30′ E.
542.38	To Cor. No. 8. At intersection of lines 4-1 and 5-6, Hawley and Poorman lodes, respectively, both of this survey. A pine post, 4½ ft. long, 5 ins. square, set 2 ft. in the ground, scribed 8-8000 A, whence No bearings available. Thence N. 86° 12′ E. Va. 14° 28′ E.

Feet.	
416.8	To Cor. No. 9. At intersection of lines 4-1 and 3-4, Hawley and Podunk lodes, respectively, both of this survey. A granite stone, 26x16x6 ins., set 18 ins. in the ground, with mound of stone, chiseled 9-8000 A, whence No bearings available. Thence S. 41° 14′ E. Va. 14° 28′ E.
555.44	To Cor. No. 10. At intersection of lines 3-4 Podunk lode of this survey, and line 4-1, Sur. No. 7000, Ajax lode, claimant unknown. A pine post, 4½ ft. long, 4 ins. square, set 18 ins. in the ground, with mound of earth, scribed 10-8000 A, whence No bearings available. Thence S. 7° 45′ W. Va. 14° 25′ E.
210.	To Cor. No. 11. On line 4-1 Sur. No. 7000 Ajax lode, at N. 7° 45′ E. 10.73 ft. from Cor. No. 4. A pine post, 5 ft. long 4 ins. square, set 2 ft. in the ground, with mound of earth and stone, scribed 11-8000 A, whence A cottonwood post, 8 ins. diam., blazed and scribed B. T. 11-8000 A, bears N. 33° 27′ W. 5 ft. Thence S. 89° 50′ W. Va. 14° 25′ E.
1329.42	To Cor. No. 1, the place of beginning. (a)
	Tract B. Beginning at Cor. No. 12. At intersection of lines 3-4, Aetna lode of this survey, and Aztec lode, unsurveyed, John Doe, claimant. A spruce post, 4½ ft. long, 4 ins. square, set 18 ins. in the ground, scribed 12-8000 A, whence

Feet.	
	A pine stump, 18 ins. diam., 3 ft. high, blazed and scribed B. S. 12-8000 A, bears N. 89° 11′ E. 9.4 ft. Thence S. 41° 14′ E. Va. 14° 30′ E.
397.33	To Cor. No. 13. A sandstone, 36x30x4 ins., set 16 ins. in the ground, with mound of stone, chiseled 13-3-8000 A, whence No bearings available. Thence S. 48° 46′ W. Va. 14° 30′ E.
200.	Cor. Nos. 2, Aetna and Podunk lodes of this survey, a point in Cumro Creek, 4 ft. wide, flows west.
330.7	To Cor. No. 14. On line 2-3 Podunk lode of this survey. A rock in place 6x4x2 ft. above the general surface, chiseled cross (X) at corner point and 14-W. C. 2-2-8000 A, whence Cor. No. 11, Tract A, of this survey bears S. 89° 50′ W. 539 ft. No other bearings available. Thence N. 89° 50′ E. Va. 14° 30′ E.
769.6	To Cor. No. 15. (a) Identical with the S. ¼ Cor. of said Sec. 17, and with the S. E. Cor. of the location. A granite stone, 12x10x6 ins. above the ground, chiseled 15-8000 A and ¼ on north face, whence No bearings available. Thence North. Va. 14° 30′ E.
265.	Cumro Creek, 4 ft. wide, flows S. 65° W.
758.1	To Cor. No. 16. (a) On line 3-4, Aztec lode, unsurveyed, at S. 72° 43′ W. 115.6 ft. from Cor. No. 3. A spruce post, 4½ ft. long, 4 ins. square, set 6

Feet.	
	ins. in the ground, to bed rock, with mound of earth and stone, scribed 16-8000 A, whence No bearings available. Thence S. 72° 43′ W. Va. 14° 28′ E.
819.8	To Cor. No. 12, the place of beginning.
	Tract C.
	Beginning at Cor. No. 17. On line 1-2 Aztec lode, unsurveyed, at S. 72° 43′ W. 22.26 ft. from Cor. No. 2. A pine post, 4½ ft. long, 4 ins. square, set 12 ins. in the ground to bed rock, with mound of stone, scribed 17-8000 A, whence Cor. No. 16, Tract B, of this survey bears South 314.2 ft. No other bearings available. Thence S. 72° 43′ W. Va. 14° 40′ E.
938.26	To Cor. No. 18. At intersection of lines 1-2 and 2-3, Aztec lode, unsurveyed, and Sur. No. 7000, Ajax lode, respectively. A cross (X) at corner point and 18-8000 A, chiseled on a granite rock in place, showing 10x3x2 ft. above the general surface, whence No bearings available. Thence N. 7° 45′ E. Va. 14° 30′ E.
530.	To Cor. No. 19. On line 2-3, Sur. No. 7000 Ajax lode, at S. 7° 45′ W. 116.4 ft. from Cor. No. 2. A granite stone, 28x10x3 ins., set 12 ins. in the ground, chiseled 19-8000 A, whence A corner of the location bears S. 89° 50′ W. 484.6 ft. No other bearings available. Thence N. 89° 50′ E. Va. 14° 30′ E.

Feet.	
824.43	To Cor. No. 20. A granite rock, 30x20x16 ins., set 16 ins. in the ground, chiseled 20-8000 A, whence A cross (X) and B. R. 20-8000 A, chiseled 4 ft. above the ground on a limestone cliff 20 ft. high, bears S. 83° 11′ E. 45.6 ft. Thence South. Va. 14° 30′ E.
247.72	To Cor. No. 17, the place of beginning. (a) Area. Tract A, containing.....14.660 acres Tract B, containing..... 9.858 " Tract C, containing..... 7.532 " Total area Cumro placer.....32.070 acres Poorman Lode. Beginning at Cor. No. 1. Identical with Cor. No. 6, Cumro placer, of this survey, whence The S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. bears S 27° 28′ W. 393.26 ft. Thence N. 17° 38′ E.
243.4	Cor. No. 5 Cumro placer, and intersect line 4-1 Hawley lode, both of this survey.
565.7	Intersect line 2-3 Hawley lode of this survey.
831.4	To Cor. No. 2. A granite stone, 27x11x9 ins., set 12 ins. in the ground, chiseled 2-8000 A, whence No bearings available. Thence N. 48° 46′ E.
61.57	Cor. No. 2, Sur. No. 6582 Roy lode, T. E. Jenkins et al., claimants.
361.57	Cor. Nos. 1, Sur. No. 6582, Roy and Raymond lodes.

Feet.	
661.57	To Cor. No. 3. Identical with Cor. No. 2, Sur. No. 6582, Raymond lode. A pine post, 5 ft. long, 4 ins. square, set 22 ins. in the ground, to bed rock, scribed 3-8000 A and 2-6582, whence No bearings available. Thence S. 41° 14′ E.
300.	To Cor. No. 4. A cedar post, 4½ ft. long, 5 ins. square, set 18 ins. in the ground, scribed 4-4-8000 A, whence Cor. No. 1, Sur. No. 7000 Ajax lode, bears N. 72° 22′ E. 422.6 ft. No other bearings available. Thence S. 48° 46′ W.
300.	Cor. Nos. 1 Aetna and Podunk lodes of this survey.
578.	To Cor. No. 5. A cedar stump, 3 ft. high, hewed to 4 ins. square, surrounded by mound of stone, scribed 5-4-8000 A, whence A cross (X) and B. R. 5-4-8000 A, chiseled on a porphyry stone, showing 9x6x4 ft. above the ground, bears N. 75° 14′ E. 32.7 ft. Thence S. 17° 38′ W.
64.4	Intersect line 2-3 Hawley lode of this survey.
386.7	Cor. No. 8 Cumro placer and intersect line 4-1 Hawley lode, both of this survey.
929.04	To Cor. No. 6. Identical with Cor. No. 7, Cumro placer of this survey. Thence N. 41° 14′ W.
350.48	To Cor. No. 1, the place of beginning. Hawley Lode. Beginning at Cor. No. 1.

Feet.	
	Identical with Cor. No. 1 of the location and with Cor. No. 4, Cumro placer, of this survey, whence The S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. bears S. 18° 4′ W. 606.1 ft. Cor. No. 1, Poorman lode, of this survey bears S. 1° 41′ W. 227.6 ft. Thence N. 3° 48′ W. Va. 14° 28′ E.
84.5	Cor. No. 3 Cumro placer of this survey.
300.	To Cor. No. 2. A sandstone, 30x12x2 ins., set 14 ins. in the ground, chiseled 2-8000 A, whence Cor. No. 2 of the location bears N. 45° W. 28.5 ft. No other bearings available. Thence N. 86° 12′ E. Va. 14° 25′ E.
185.	Intersect line 1-2 Poorman lode of this survey.
507.3	Intersect line 5-6 Poorman lode of this survey.
567.6	Intersect line 3-4 Podunk lode of this survey.
926.7	Intersect lines 1-2 Podunk and Aetna lodes of this survey.
1264.7	To Cor. No. 3. A granite stone, 26x14x8 ins., set 12 ins. in the ground with mound of stone, chiseled 3-8000 A, whence Cor. No. 3 of the location bears N. 86° 12′ E. 235.3 ft. Cor. No. 1, Sur. No. 7000 Ajax lode, bears N. 11° E. 529.9 ft. Cor. No. 1, Aztec lode, unsurveyed, bears S. 32° 30′ W. 378.4 ft. No other bearings available. Thence S. 3° 48′ E. Va. 14° 26′ E.

Feet.	
150.	Intersect line 4-1 Sur. No. 7000, Ajax lode at S. 7° 45′ W. 676 ft. from Cor. No. 1.
250.6	Intersect line 1-2 Aztec lode, unsurveyed, at N. 72° 43′ E. 229.8 ft. from Cor. No. 1.
300.	To Cor. No. 4. A pine post, 4½ ft. long, 4 ins. square, set 18 ins. in the ground, scribed 4-8000 A, whence Cor. No. 4 of the location bears N. 86° 12′ E. 235.3 ft. No other bearings available. Thence S. 86° 12′ W. Va. 14° 15′ E.
30.8	Intersect line 4-1 Sur. No. 7000 Ajax lode at S. 7° 45′ W. 829.1 ft. from Cor. No. 1.
108.3	Intersect lines 1-2 Aetna and Podunk lodes of this survey.
206.	Intersect line 1-2 Aztec lode, unsurveyed, at N. 72° 43′ E. 18.1 ft. from Cor. No. 1.
458.4	Cor. No. 9 Cumro placer and intersect line 3-4 Podunk lode, both of this survey.
875.2	Cor. No. 8 Cumro placer and intersect line 5-6 Poorman lode , both of this survey.
1197.5	Cor. No. 5 Cumro placer and intersect line 1-2 Poorman lode, both of this survey.
1264.7	To Cor. No. 1, the place of beginning.
	Aetna Lode.
	Beginning at Cor. No. 1. On line 4-5 Poorman lode of this survey. A pine post 4½ ft. long, 4 ins. square, set 18 ins. in the ground, scribed 1-1-8000 A, whence The S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. bears S. 38° 2′ W. 1,465 ft.

Feet.	
	Cor. No. 1 Aztec lode, unsurveyed, bears S. 32° 19′ E. 607.76 ft. Cor. No. 3, Hawley lode of this survey bears S. 69° 46′ E. 561.9 ft. No other bearings available. Thence S. 41° 14′ E.
288.3	Intersect line 2-3 Hawley lode of this survey.
641.2	Intersect line 1-2 Aztec lode, unsurveyed, at N. 72° 43′ E. 103.1 ft. from Cor. No. 1.
666.1	Intersect line 4-1 Hawley lode of this survey.
766.9	Intersect line 4-1, Sur. No. 7000, Ajax lode at S. 7° 45′ W. 910.9 ft. from Cor. No. 1.
969.5	Intersect line 3-4 Aztec lode, unsurveyed, at N. 72° 43′ E. 236.3 ft. from Cor. No. 4.
1164.7	Intersect line 2-3, Sur. No. 7000, Ajax lode at N. 7° 45′ E. 328.2 ft. from Cor. No. 3.
1500.	To Cor. No. 2. On line 13-14 Cumro placer of this survey. Not set, as it falls in the center of Cumro Creek, where permanent corner could not be established, whence Witness corner to Cor. No. 2, identical with Cor. No. 14 Cumro placer of this survey, bears S. 48° 46′ W. 30.7 ft. Cor. No. 3, Sur. No. 7000, Ajax lode bears S 74° 38′ W. 275.2 ft. Thence N. 48° 46′ E.
300.	To Cor. No. 3. Identical with Cor. No. 13 Cumro placer of this survey. Thence N. 41° 14′ W.
397.33	Cor. No. 12 Cumro placer of this survey and inter-

Feet.	
	sect line 3-4 Aztec lode, unsurveyed, at N. 72° 43′ E. 564.6 ft. from Cor. No. 4.
596.43	Intersect line 2-3, Sur. No. 7000, Ajax lode at N 7° 45′ E. 725.8 ft. from Cor. No. 3.
725.6	Intersect line 1-2 Aztec lode, unsurveyed, at N. 72° 43′ E. 431.3 ft. from Cor. No. 1.
994.	Intersect line 4-1, Sur. No. 7000, Ajax lode at S. 7° 45′ W. 513.2 ft. from Cor. No. 1.
1500.	To Cor. No. 4. Identical with Cor. No. 4 Poorman lode of this survey. Thence S. 48° 46′ W.
300.	To Cor. No. 1, the place of beginning.
	Podunk Lode. Beginning at Cor. No. 1. Identical with Cor. No. 1 Aetna lode of this survey, whence Cor. No. 2 of the location bears N. 48° 46′ E. 22 ft. The S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. bears S. 38° 2′ W. 1,465 ft. Thence S. 41° 14′ E.
288.3	Intersect line 2-3 Hawley lode of this survey.
641.2	Intersect line 1-2 Aztec lode, unsurveyed, at N. 72° 43′ E. 103.1 ft. from Cor. No. 1.
666.1	Intersect line 4-1 Hawley lode of this survey.
766.9	Intersect line 4-1, Sur. No. 7000, Ajax lode at S. 7° 45′ W. 910.9 ft. from Cor. No. 1.
969.5	Intersect line 3-4 Aztec lode, unsurveyed, at N. 72° 43′ E. 236.3 ft. from Cor. No. 4.

Feet.	
1164.7	Intersect line 2-3, Sur. No. 7000, Ajax lode at N. 7° 45′ E. 328.2 ft. from Cor. No. 3.
1500.	To Cor. No. 2. In Cumro Creek. Identical with Cor. No. 2 Aetna lode of this survey, whence Cor. No. 3 of the location bears N. 48° 46′ E. 22 ft. Thence S. 48° 46′ W.
30.7	Witness corner to Cor. No. 2. Identical with Witness corner to Cor. No. 2 Aetna lode, and with Cor. No. 14 Cumro placer, both of this survey.
250.	Witness corner to Cor. No. 3. A granite stone, 30x20x4 ins., set 14 ins. in the ground, with mound of stone, chiseled W. C. 3-8000 A, whence A cedar stump, 14 ins. diam., 2 ft. high, blazed and scribed B. S. W. C. 3-8000 A, bears N. 7° 56′ W. 8.4 ft. Pikes Peak bears N. 5° E.
278.	To Cor. No. 3. Not set, as it falls on the face of an inaccessible granite cliff. Identical with Cor. No. 4 of the location. Thence N. 41° 14′ W.
37.	Cumro Creek, 4 ft. wide, course S. 80° W.
155.	Intersect line 3-4, Sur. No. 7000, Ajax lode, at N. 82° 15′ W. 46.3 ft. from Cor. No. 3.
491.3	Cor. No. 10 Cumro placer of this survey and intersect line 4-1, Sur. No. 7000, Ajax lode, at N. 7° 45′ E. 220.7 ft. from Cor. No. 4.
1046.7	Cor. No. 9 Cumro placer and intersect line 4-1 Hawley lode both of this survey.

Feet.	
1424.5	Intersect line 2-3, Hawley lode, of this survey.
1500.	To Cor. No. 4. Identical with Cor. No. 5 Poorman lode of this survey, and with Cor. No. 1 of the location. Thence N. 48° 46′ E.
278.	To Cor. No. 1, the place of beginning. Variation at all corners of the Poorman, Aetna and Podunk lodes, 14° 30′ E.
	Lode Line. As near as can be determined from present development, the veins of the several lodes embraced in this survey extend as follows: (b)

(b).—This paragraph might be changed to read as follows: As near as can be determined from present development, the veins of the several lodes embraced in this survey extend from their respective discovery points as follows: Poorman lode, 619.8 ft. N. 48° 46′ E. and 880.2 ft. S. 17° 38′ W. from the center of the discovery shaft, etc. This form makes it necessary to change description of discovery workings under "Improvements" as follows: The discovery shaft of the Poorman lode, the center of which being the discovery point, bears, etc. The discovery cut of the Podunk lode, the center of face of which being the discovery point, bears, etc. The incline discovery shaft of the Ætna lode, the center or mouth of which, being the discovery point, bears, etc. Another description of these discovery workings commonly used, is as follows: The discovery shaft of the Poorman lode, the center of which is on the center line at 619.8 ft. from the center of line 3-4, etc. If, as in the case of the Podunk lode, the discovery point is on the lode line, and not the center line, the description would read as follows: The discovery cut of the Podunk lode, the center of the face of which is on the lode line, at 140 ft. from a point on line 4-1, at N. 48° 46′ E. 150 ft. from Cor. No. 4, etc. The incline discovery shaft of the Ætna lode, the center of the mouth of which is on the center line, 75 ft. from the center line 4-1, etc.

Feet.

Poorman lode, 619.8 ft. N. 48° 46′ E. and 880.2 ft. S. 17° 38′ W. from the center of the discovery shaft.

Hawley lode, 573.7 ft. N. 86° 12′ E. and 691 ft. S. 86° 12′ W. from the discovery point in discovery tunnel.

Aetna lode, 75 ft. N. 41° 14′ W. and 1,425 ft. S. 41° 14′ E. from the center of mouth of discovery shaft.

Podunk lode, 140 ft. N. 41° 14′ W. and 1,360 ft. S. 41° 14′ E. from center of face of discovery cut.

Area.

Total area Hawley lode	8.710	acres
Area in conflict with Poorman lode of this survey	2.220	"
Sur. No. 7000 Ajax lode	.053	"
Aztec lode, unsurveyed	.117	"
Aztec lode, unsurveyed (exclusive of its conflict with Sur. No. 7000, Ajax lode)	.089	"
Total area Hawley lode	8.710	acres
Less area in conflict with Poorman lode of this survey ..... 2.220 acres		
Sur. No. 7000, Ajax lode.. .053 "		
Aztec lode, unsurveyed.. .089 " =	2.362	"
Net area Hawley lode	6.348	acres
Total area Aetna lode	10.331	acres
Area in conflict with Hawley lode of this survey	1.537	"
Sur. No. 7000, Ajax lode	2.738	"
Sur. No. 7000, Ajax lode (exclusive of its conflict with Hawley lode of this survey)	2.685	"
Aztec lode, unsurveyed	2.261	"
Aztec lode, unsurveyed (exclusive of its conflict with Hawley lode of		

Feet.

this survey) ..... 2.167 acres

Aztec lode, unsurveyed (exclusive of its conflict with Sur. No. 7000, Ajax lode) ..... .484 "

Aztec lode, unsurveyed (exclusive of its conflict with Hawley lode of this survey and Sur. No. 7000, Ajax lode) ..... .418 "

Total area Aetna lode.....10.331 acres

Less area in conflict with Hawley lode of this survey .....1.537 acres

Sur. No. 7000, Ajax lode..2.685 "

Aztec lode, unsurveyed.. .418 " = 4.640 "

Net area Aetna lode..... 5.691 acres

Total area Podunk lode..... 9.573 acres

Area in conflict with Hawley lode of this survey ..... 2.411 "

Sur. No. 7000, Ajax lode..... 2.526 "

Aztec lode, unsurveyed..... 1.169 "

Aztec lode, unsurveyed (exclusive of its conflict with Hawley lode of this survey) ..... 1.147 "

Aztec lode, unsurveyed (exclusive of its conflict with Sur. No. 7000, Ajax lode) ..... .811 "

Aztec lode, unsurveyed (exclusive of its conflict with Hawley lode of this survey and Sur. No. 7000, Ajax lode) ..... .789 "

Feet.	
	Total area Podunk lode..... 9.573 acres Less area in conflict with Hawley lode of this survey .....2.411 acres Sur. No. 7000, Ajax lode..2.516 " Aztec lode, unsurveyed.. .789 " = 5.716 " Net area Podunk lode..... 3.857 acres Net area Hawley lode..... 6.348 " Net area Aetna lode..... 5.691 " Total and net area Poorman lode....10.331 " Net area lode claim.....26.227 acres
	Survey No. 8000 B. Poorman Mill Site. Beginning at Cor. No. 1. A spruce post 5 ft. long, 4 ins. square, set 18 ins. in the ground, scribed 1-8000 B, whence Cor. No. 6, Sur. No. 8000 A, Poorman lode, bears N. 50° 8′ E. 3,782 ft. The N. E. Cor. Sec. 19, T. 14 S., R. 69 W. of the 6th P. M. bears N. 46° 48′ E. 3,416.9 ft. No other bearings available. Thence S. 85° 51′ W.
65.	Cumro Creek, 4 ft. wide, flows N. 65° W.
858.	Cumro Creek, 4 ft. wide, flows South.
921.2	To Cor. No. 2. A granite stone, 28x12x10 ins., set 12 ins. in the ground, with mound of stone, chiseled 2-8000 B., whence A pine, 12 ins. diam., blazed and scribed B. T. 2-8000 B, bears West 9.5 ft. Thence N. 37° 55′ E.
467.66	To Cor. No. 3. A granite stone, 30x12x8 ins., set 18 ins. in the ground, with mound of stone, chiseled 3-8000 B., whence No bearings available. Thence S. 64° 25′ E.

Feet.	
700.	To Cor. No. 1, the place of beginning. Containing 3.671 acres. Variation at all corners 14° 45′ E. The surveys of the Poorman and Aetna lodes and the Poorman mill site are identical with the respective locations, as staked upon the ground. Location. This claim is located in the S. W. ¼ of Sec. 17, the N. E. ¼ of Sec. 19, and the N. W. ¼ of Sec. 20, T. 14 S., R. 69 W. of the 6th P. M. (c) Expenditure of Five Hundred Dollars. I certify that the value of the labor and improvements upon this claim placed thereon by the claimants and their grantors, is not less than five hundred dollars, and that said improvements consist of: Placer workings, the center of the northeasterly end of which bears from Cor. No. 15 Cumro placer, N. 46° W. 285 ft., averaging 40 ft. wide and 8 ft. deep, and extending S. 62° W. 120 ft. along the bed of Cumro Creek. Value, $800. The discovery shaft of the Poorman lode, which bears from Cor. No. 5 N. 56° 48′ W. 155.7 ft. 6x4 ft. 12 ft. deep. (b) Value, $100. The discovery cut of the Podunk lode, the face of which bears from Cor. No. 4 S. 88° 13′ E. 205.2 ft., 5 ft. wide, 10 ft. face, running N. 50° E. 24 ft. in earth and rock. (b) Value, $110.

(c).—In an unsurveyed portion of, or suspended portion of, the public domain, this paragraph might be changed to read: As near as can be determined from present conditions of the public survey, this claim is located in, etc.

The incline discovery shaft of the Aetna lode the mouth of which is on the center line, 75 ft. from the center of line 4-1, 4½x6 ft., 24 ft. deep in rock, timbered, course S. 48° E. dip 60°. (b)

Value, $250.

The last 120 ft. of a tunnel, the mouth of which bears from Cor. No. 6 Poorman lode N. 67° 48′ E. 582 ft., 5x6 ft., running N. 10° 44′ W. 515 ft. to breast. The point of discovery of the Hawley lode is in this tunnel 475 ft. from the mouth, and bears from Cor. No. 1 N. 75° 52′ E. 702.5 ft.

Value of last 120 ft., $2,300.

This tunnel is in course of construction for the development of this claim and the contiguous claim, Sur. No. 6582, Roy and Raymond lodes, claimants herein. An undivided half interest in the first 375 ft. of this tunnel has been credited to each of the last two mentioned lodes. No other portion or interest in this tunnel has been credited to any other claim.

The surface embraced in this claim ascends rapidly from the mouth of the tunnel towards Cor. No. 3 of the Poorman lode, the northerly ends of the Poorman, Aetna and Podunk lodes being from 300 to 500 ft. higher than the mouth of the tunnel, The veins of the Aetna and Podunk lodes dip about 60° to the S. W. The tunnel, described and included in the estimate of expenditure, continued in its present course, will cut the veins of the several locations at great depth, whereby, by one system of workings, and one plant of machinery, the entire claim can be most advantageously and economically developed.

A shaft on the center line of the Hawley lode, 672 ft. from the center of line 1-2, 3½x6 ft., 20 ft. deep in earth and rock, timbered, at the bottom of which is a drift 4x6 ft., running N. 86° E. 18 ft.

Value of shaft and drift, $300.

Other Improvements.

A shaft, which bears from Cor. No. 20 Cumro placer, S. 48° 30' W. 305 ft., 3x5 ft., 12 ft. deep in earth and gravel. A. K. Smith, claimant.

A log cabin, the West corner of which bears from Cor. No. 13 Cumro placer, S. 40° E. 120 ft., 12x16 ft., course of long sides N. 44° E.

A log cabin, the N. W. Cor. of which bears from Cor. No. 3, Sur. No. 8000 B, Poorman mill site, S. 10° 40' E. 107 ft., 16 ft. square, course of sides S. 3° E. Said cabins belong to claimants herein.

Instrument.

These surveys were made with a Gurley Light Mountain Transit. The courses were deflected from the true meridian as determined by direct solar observation. The distances were measured with 50-ft. and 500-ft. steel tapes.

Note:—The disagreements between these field notes and the amended location certificate of the Hawley lode, and the location certificates of the Aetna lode and the Poorman mill site, with regard to the position of the discovery point on the lode line of the Hawley lode, and the courses of the boundary lines of the Aetna lode and the Poorman mill site, are due to errors in the latter.

Note:—Neither E. E. Ames nor myself, who appear as locators of the Hawley lode, held any interest, directly or indirectly, in this claim at the time of making the survey, having sold our interests in June, 1890.

Report:

All lines of these surveys of the Cumro placer, the Poorman, Hawley, Podunk and Aetna lodes, and the Poorman mill site, and the tie lines between the same, and all tie lines to conflicting and contiguous surveys, and the respective ties to the S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. were made direct upon the ground (d), except the tie from Cor. No. 2 Aetna lode, to Cor. No. 3, Sur. No. 7000, Ajax lode, which was determined by the following tie run on the ground from W. C. Cor. No. 2 to Cor. No. 3, Sur. No. 7000, Ajax lode, S. 77° 35' W. 247.9 ft.

The S. W. Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M., to which connection is given, is a stone, 26x27x18 ins., marked two notches on south face and four on north face.

The S. ¼ Cor. Sec. 17, T. 14 S., R. 69 W. of the 6th P. M. is a stone 24x17x19 ins., marked ¼ on north face.

The corners on the ground to which connection is given are described as follows:

Cors. Nos. 1, 2 and 3, Sur. No. 7000, Ajax lode, are stones, marked 1-7000, 2-7000 and 3-7000 respectively. Cor. No. 4 is a post marked 4-7000.

Cor. Nos. 1, Sur. No. 6582, Roy and Raymond lodes, is a stone, marked 1-1-6582. Cors. Nos. 2 are posts marked 2-6582 and 2-6582, respectively.

(d).—Or, "by separate and distinct traverses, all lines of which were run direct upon the ground," as the case may be.

The courses, and where necessary the lengths, of all intersecting, coincident and coterminous boundary lines of conflicting and contiguous surveys were determined by survey where corners were found standing, and were found correct as approved (except as hereinafter specified). Where corners were not found, such lines are shown as given in the approved field notes thereof. (e)

Final Oaths for Surveys.

List of Names.

A list of the names of the individuals employed by **A. L. Hawley,** United States Deputy Mineral Surveyor, to assist in running, measuring, and marking the lines, corners and boundaries described in the foregoing field notes

(e).—The last sentence in the above is not really necessary in this particular case, as all corners of conflicting surveys have been reported as found. It would be necessary, however, should any corners be missing. Reports of errors found either in the boundary or tie lines of other surveys should follow the last paragraph.

In short, the report should state: (1) How lines of the survey, tie lines between the same, tie lines to conflicting and contiguous surveys and to the corner or corners of the public survey (or to the U. S. Locating Monument) were determined. (2) Description of corner of public survey or U. S. L. M. to which connection is given. (3) Description of such corners of conflicting or contiguous surveys to which connections are given, also such other corners or visible evidences as determine the courses and distances of intersecting, coincident or coterminous lines of conflicting or contiguous surveys. (4) A statement of the findings as to the courses and lengths of such intersecting coincident and coterminous boundary lines of conflicting and contiguous surveys. (5) Reports of errors found either in the boundary or tie lines of other surveys.

of the survey of the mining claim of **T. E. Jenkins et al.**, known as the **Cumro placer, and Poorman, Hawley, Aetna and Podunk lodes, and Poorman mill site**, and showing the respective capacities in which they acted.

....., Chainman.
E. E. Ames, Chainman.
G. W. Trommlitz, Axman.
....., Flagman.

Final Oaths of Assistants.

We, **E. E. Ames and G. W. Trommlitz,** do solemnly swear that we assisted **A. L. Hawley,** United States Deputy Mineral Surveyor, in marking the corners and surveying the boundaries of the mining claim of **T. E. Jenkins et al.**, known as the **Cumro placer, and Poorman, Hawley, Aetna and Podunk lodes, and Poorman mill site,** represented in the foregoing field notes as having been surveyed by said deputy mineral surveyor and under his direction; and that said survey has been in all respects, to the best of our knowledge and belief, faithfully and correctly executed, and the corner and boundary monuments established according to law and the instructions furnished by the United States Surveyor-General for **Colorado.**

....., Chainman.
(Seal) **E. E. Ames,** Chainman.
G. W. Trommlitz, Axman.
....., Flagman.

Subscribed and sworn to by the above-named persons before me this **13th** day of **February, 1893.**

A. L. HAWLEY,
Notary Public,
El Paso County, Colorado.

My commission expires July 28th, 1896.

Final Oath of U. S. Deputy Mineral Surveyor.

I, **A. L. Hawley,** U. S. Deputy Mineral Surveyor, do sol-

emnly swear that, in pursuance of instructions received from the United States Surveyor General for Colorado, dated February 6th, 1893, I have, in strict conformity to the laws of the United States, the official regulations and instructions thereunder, and the instructions of said Surveyor General, faithfully and correctly executed the survey of the Mining Claim of T. E. Jenkins et al., known as the Cumro placer and Poorman, Hawley, Aetna, and Podunk lodes, and Poorman mill site, situate in Pike's Peak Mining District, El Paso County, Colorado, in Sections 17, 19 and 20, Township No. 14 S., Range No. 69 W. of the 6th P. M., and designated as Survey No. 8000 A and B, as represented in the foregoing field notes, which accurately show the boundaries of said mining claim as distinctly marked by monuments on the ground, and described in the attached copy of each location certificate, which was received by me from the Surveyor General with said instructions, and that all the corners of said survey have been established and perpetuated in strict accordance with the law, official regulations and instructions thereunder; and I do further solemnly swear that the foregoing are the true and original field notes of said survey and my report therein, and that the labor expended and improvements made upon said mining claim by claimants or their grantors are as therein fully stated, and that the character, extent, location and itemized value thereof are specified therein with particularity and full detail, and that no portion of said labor or improvements so credited to this claim has been included in the estimate of expenditures upon any other claim.....

A. L. HAWLEY,
U. S. Deputy Mineral Surveyor.

Subscribed and sworn to by the said A. L. Hawley, U. S. Deputy Mineral Surveyor, before me, a Justice of the Peace in and for El Paso County, Colorado, this 20th day of February, 1893.

GEO. K. KIMBALL,
Justice of the Peace.

Placer Location Certificate.

Know All Men by These Presents, That I, T. E. Jenkins, the undersigned citizen of the United States, resident of the County of Arapahoe and State of Colorado, having complied with the provisions of Chapter 6, Title XXXII, of the Revised Statutes of the United States, and with the local customs, laws and regulations, claim by right of discovery and location, as a placer claim, the following described premises, situate, lying and being in Pike's Peak Mining District, County of El Paso and State of Colorado, to-wit:

The S. E. ¼ of the S. W. ¼, and the S. ½ of the S. W. ¼ of Sec. 17, T. 14 S., R. 69 W. of the 6th P. M.

To be known as the Cumro Placer.

Located May 1st, 1892.

Date of certificate, June 4th, 1892.

T. E. JENKINS.

Location Certificate—Lode Claim.

STATE OF COLORADO, }
County of El Paso. } ss.

Know All Men by These Presents, That O. F. Shattuck the undersigned has this 4th day of May, 1892, located and claimed, and by these presents does locate and claim by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, 1,500 linear feet and horizontal measurement on the Poorman lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with 150 feet on the westerly side and 150 feet on the easterly side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges, or deposits and surface ground within the lines of said claim 620 feet running N. 48° 46′ E. from centre of discovery shaft and 880 feet running S. 17° 38′ W. from centre of discovery shaft, said discovery shaft

being situate upon said lode, vein, ledge or deposit, and within the lines of said claim in Pike's Peak Mining District, County of El Paso and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, whence Cor. to Secs. 17, 18, 19, and 20, T. 14 S., R. 69 W. bears S. 27° 28' E. 393.26 ft.

Thence N. 17° 38' E. 831.34 ft. to Cor. No. 2.

Thence N. 48° 46' E. 661.7 ft. to Cor. No. 3.

Thence S. 41° 14' E. 300 ft. to Cor. No. 4.

Thence S. 48° 46' W. 578 ft. to Cor. No. 5.

Thence S. 17° 38' W. 929.04 ft. to Cor. No. 6.

Thence N. 41° 14' W. 350.48 ft. to Cor. No. 1, the place of beginning.

Said lode was discovered on the 12th day of April, A. D. 1892.

Attest: .....

Date of Location May 4th, A. D. 1892.

Date of Certificate June 1st, A. D. 1892.

O. F. SHATTUCK, (Seal.)

Amended Location Certificate—Law of 1889.

STATE OF COLORADO, }
County of El Paso. } ss.

Know All Men by These Presents, That A. L. Hawley and E. E. Ames, the undersigned have this 4th day of May, 1888, amended, located and claimed, and by these presents do amend, locate and claim, by right of discovery and amended location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General laws of Colorado, and with local customs, laws and regulations 1500 linear feet and horizontal measurement on the Hawley lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 150 feet on each side of the middle of said vein at the surface, so far as can be determined from present developments,

and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 800 feet running easterly from center of discovery point in tunnel and 700 feet running westerly from center of discovery point, said discovery point being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in Pike's Peak Mining District, County of El Paso and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, whence Cor. to Secs. 17, 18, 19, and 20, T. 15 S., R. 69 W. bears S. 18° 4' E. 606.1 ft.

Thence N. 3° 48' E. 300 ft. to Cor. No. 2.

Thence N. 87° E. 1500 ft. to Cor. No. 3.

Thence S. 3° 48' W. 300 ft. to Cor. No. 4.

Thence S. 87° W. 1500 ft. to Cor. No. 1, the place of beginning.

This being the same lode originally located on the 17th day of September, 1886, and recorded on the 12th day of December, 1886, in Book 4, Page 48, in the office of the Recorder of El Paso County. This further and amended certificate of location is made without waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record.

Said lode was discovered the 12th day of September, A. D. 1886.

Attest: .....

Date of Amended location May 4th. A. D. 1888.

Date of amended certificate July 14th, A. D. 1888.

A. L. HAWLEY, (Seal.)

E. E. AMES, (Seal.)

Location Certificate—Lode Claim.

STATE OF COLORADO, }
County of El Paso. } ss.

Know All Men by These Presents, That Grant Safely, the undersigned has this 4th day of June, 1892, located and claimed, and by these presents does locate and claim by

right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, 1500 linear feet and horizontal measurement on the **Aetna** lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with 150 feet on the **southwesterly** side and 150 feet on the **northeasterly** side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges, or deposits and surface ground within the lines of said claim 75 feet running N. 40° W. from centre of discovery cut and 1425 feet running S. 40° E. from centre of discovery cut, said discovery cut being situate upon said lode, vein, ledge or deposit, and within the lines of said claim in **Pike's Peak** Mining District, County of **El Paso** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, whence S. W. Cor. Sec. 17, T. 15 S., R. 69 W. bears S. 38° 2' E. 1465 ft.

Thence S. 40° E. 1500 ft. to Cor. No. 2.
Thence N. 50° E. 300 ft. to Cor. No. 3.
Thence N. 40° W. 1500 ft. to Cor. No. 4.
Thence S. 50° W. 300 ft. to Cor. No. 1, the place of beginning.

Said lode was discovered on the 1st day of May, A. D. 1892.

Date of Location June 4th, A. D. 1892.

Date of Certificate July 6th, A. D. 1892.

GRANT SAFELY, (Seal.)

Additional and Amended Location Certificate—Law of 1889.

STATE OF COLORADO, }
County of El Paso. } ss.

Know All Men by These Presents, That John H. Routt, the undersigned, has this 4th day of May, 1891, amended, located and claimed, and by these presents does amend, locate and claim, by right of the original discovery and

this additional and amended location certificate, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General Statutes of Colorado, and with local customs, laws and regulations 1500 linear feet and horizontal measurement on the **Podunk** lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 150 feet on each side of the middle of said vein at the surface, so far as can be determined from present developments, and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 140 feet running N. 41° 14′ W. from center of discovery cut and 1360 feet running S. 41° 14′ E. from center of discovery cut, said discovery cut being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in **Pike's Peak** Mining District, County of **El Paso** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, whence the S. W. Cor. Sec. 17, T. 15 S., R. 69 W. bears S. 38° 2′ W. 1465 ft.

Thence S. 41° 14′ E. 1500 ft. to Cor. No. 2.
Thence S. 48° 46′ W. 300 ft. to Cor. No. 3.
Thence N. 41° 14′ W. 1500 ft. to Cor. No. 4.
Thence N. 48° 46′ E. 300 ft. to Cor. No. 1, the place of beginning.

This being the same lode originally located on the 6th day of April, 1888, and recorded on the 14th day of June, 1888, in Book 3, Page 48, in the office of the Recorder of El Paso County. This further additional and amended certificate of location is made without waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record. and of taking in and acquiring all forfeited or abandoned, overlapping ground, and of taking in any part of any overlapping claim which has been abandoned, and of securing

all the benefits of said Section 2409 of the General Statutes of Colorado.

Said lode was discovered the 1st day of April, A. D. 1888.

Date of Additional and Amended Certificate June 14th, A. D. 1891.

JOHN H. ROUTT, (Seal.)

Location Certificate of Mill Site.

To All Whom These Presents May Concern:

Know ye that I, A. E. Lowe, of the County of Arapahoe, and State of Colorado, do hereby declare and publish as a legal notice to all the world that I have a valid right to the occupation, possession and enjoyment of all and singular that tract or parcel of land not exceeding five acres, situate, lying and being in Pike's Peak Mining District, in the County of El Paso in the State of Colorado, bounded and described as follows, to-wit: Poorman Mill Site, beginning at Cor. No. 1, whence the N. E. Cor Sec. 19, T. 14 S., R. 69 W. bears N. 46° 48′ E. 3416.9 ft.

Thence S. 85° 50′ W. 921.2 ft. to Cor. No. 2.

Thence N. 37° 00′ E. 467.66 ft. to Cor. No. 3.

Thence S. 64° 00′ E. 700 ft. to Cor. No. 1, the place of beginning,

Containing 4 acres more or less.

Variation 14° 45′ E.

together with all and singular the hereditaments and appurtenances thereunto belonging or in anywise appertaining.

Witness my hand and seal, this 5th day of December in the year of our Lord one thousand eight hundred and ninety one.

A. E. LOWE, (Seal.)

(Title Page to Report Under Circular "N" of September 23, 1882.)

Report

Under General Land Office Circular "N" of September 23, 1882, upon the Placer Mining Claim known as the **Cumro placer**, claimed by **T. E. Jenkins et al.**, situate in **Pike's Peak** Mining District, **El Paso** County, **Colorado**, embracing **32.07 acres, and forming a portion of the S. half of the S. W. quarter** in Sec. **17**, Town. **14 S.**, Range **69 W.** of the **6th P. M.**

Examination made **February 15th, 1893,**

By **A. L. HAWLEY,**

U. S. Deputy Mineral Surveyor.

Survey No. 8000 A.

Cumro Placer.

a The soil embraced in this claim consists of decomposed mineral-bearing granite on the mountain slopes, and auriferous sand and gravel along the creek bottom, all covered with a thin layer of loam and alluvium supporting a scant growth of grass and sage brush, with scattering pine, spruce, cedar and cottonwood timber.

b The only stream passing through this claim is Cumro creek, 4 ft. wide, and about 2 ft. deep, which crosses the extreme southeast corner.

A log cabin, the west corner of which bears from Cor. No. 13 S. 40° E. 120 ft., 12x16 ft., course of long sides N. 44° E.

c The surface and underground workings on this claim consist of:

A tunnel, the mouth of which bears from Cor. No. 7 N. 67° 48′ E. 582 ft. 5x6 ft., running N. 10° 44′ W. 515 ft. to breast.

A shaft, which bears from Cor. No. 28 S. 48° 30′ W. 305 ft., 3x5 ft., 12 ft. deep in earth and rock. Placer workings, the center of the northeasterly end of which bears from Cor. No. 15 N. 46° W. 285 ft., averaging 40 ft. wide and 8 ft. deep, and extending S. 62° W. 120 ft. along the bed of Cumro creek.

d The nearest postoffice to the claim is Jamestown, a mining camp of about 300 population, located on Brush creek about two miles south of the claim. The nearest railroad station is Tie Siding, a spur and flag station on the Denver, Apex and Western R. R., at the confluence of Cumro and Plum creeks, about 6 miles southwesterly from the claim.

e Other than the system of lode deposits adjoining and forming a part of this claim, there are none nearer than Carbonate, situate about four miles to the northeast.

f This claim is peculiarly adapted for placer mining purposes, inasmuch as the contour of the surface and the character and nature of the soil are such that it can be most advantageously and cheaply worked by hydraulic giants and the tailings be rapidly and easily disposed of. Cumro creek carries about 50 cu. ft. of water per second during the dry season, being an abundance of water for working the claim. As yet no water has been taken upon the claim for its development, except in washing the placer workings hereinbefore described; but by a survey it has been found that by a ditch not over one mile in length, water can be taken from Cumro creek onto the highest portions of the claim. It being the express intention of the claimants to work the claim in this manner.

g The works and expenditures made by the claimants for the development of the claim consists of the placer workings described under paragraph c of this report.

h There are no mines, salt licks, salt springs, or mill seats upon this claim.

Oath of U. S. Deputy Mineral Surveyor.

Under General Land Office Circular "N" of September 23, 1882.

I, **A. L. Hawley**, U. S. Deputy Mineral Surveyor, do solemnly swear that in pursuance of an order received from the U. S. Surveyor General for **Colorado**, dated **February 6th**, 1893, I have made, under the provisions of General Land Office Circular "N," approved September 23, 1882, a personal and thorough examination, upon the prem-

ises, of the placer mining claim of T. E. Jenkins et al, known as the Cumro placer, situate in Pike's Peak Mining District, El Paso County, Colorado, embracing 32.07 acres and forming a portion of the S. ½ of the S. W. ¼ of Sec. 17 in Township No. 14 S., Range No. 69 W. of the 6th P. M., and that my report of such examination, hereto attached, is specific and in detail, and is a full and true statement of the facts upon all the points specified in said Circular.

A. L. HAWLEY,
U. S. Deputy Mineral Surveyor.

Subscribed and sworn to by the said A. L. Hawley, U. S. Deputy Mineral Surveyor, before me, a notary public in and for El Paso County, Colorado, this 20th day of February, 1893.

B. F. CLARK,
Notary Public.

My commission expires December 20, 1893.

Corroborative Affidavit Under Paragraph 62, General Mining Circular, Approved June 24, 1899.

STATE OF COLORADO, }
County of El Paso. } ss.

W. H. Wilson and J. P. Thompson, being first duly sworn, severally depose and say that he is personally and well acquainted with the placer-mining claim of T. E. Jenkins et al., known as the Cumro placer, situate in Pike's Peak Mining District, El Paso County, Colorado, embracing 32.07 acres and forming a portion of the S. ½ of the S. W. ¼ of Sec. 17, in Township No. 14 S., Range No. 69 W. of the 6th P. M.; and also with the character of all the land included in said claim, and has been so acquainted for 10 and 12 years last past; that his knowledge of said claim and land is derived from prospecting the ground and working the claim and is such as to enable him to testify understandingly with regard thereto; that he has carefully read the foregoing report of A. L. Hawley, U. S. Deputy Mineral Surveyor, and that to his own personal knowledge said report is in all respects true and accurate.

W. H. WILSON.
J. P. THOMPSON.

Subscribed and sworn to by the above-named persons before me this 20th day of February, 1893.

(Seal.) B. F. CLARK,
Notary Public.

My commission expires December 20, 1893.

CHAPTER VII.

Office United States Surveyor-General.

The province of the office of Surveyor-General for any district is to supervise the surveys of the public land in that district.

The agricultural land is subdivided into townships six miles square, each township again into thirty-six sections, each one mile square, containing six hundred and forty acres, which can be still further subdivided to suit the convenience of persons desiring to obtain title thereto. This surveying work is done by contract made between the surveyor appointed a deputy surveyor and the government, the price paid the deputy being from five to seven dollars per mile for subdivision, seven to eleven dollars per mile for township exteriors, and from nine to thirteen dollars per mile for connection and meander lines. After these surveys are once made and approved by the Surveyor-General and the General Land Office, the Surveyor-General has no more authority in the matter, unless on account of fraudulent surveys or some similar cause the surveys in question are suspended, and new and correct surveys are made.

In surveying mineral claims, a different method entirely is followed. The surveying is done by United States Deputy Mineral Surveyors employed by the owner of the claim to be patented. These Deputy Mineral Surveyors are appointed by the Surveyor-General, who requires the applicant to pass an examination or not, as he sees fit. Section 2334 of the revised statute making provision for these appointments being in part as follows:

Sec. 2334. The Surveyor-General of the United States may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appoint-

ment to survey mining claims. The expenses of the survey of vein or lode claims, and the survey and subdivision of placer claims into smaller quantities than one hundred and sixty acres, together with the cost of publication of notices, shall be paid by the applicants, and they shall be at liberty to obtain the same at the most reasonable rates, and they shall also be at liberty to employ any United States Deputy Surveyor to make the survey. The Commissioner of the General Land Office shall also have power to establish the maximum charges for surveys and publication of notices under this chapter; and, in case of excessive charges for publication, he may designate any newspaper published in a land district where mines are situated for the publication of mining notices in such district, and fix the rates to be charged by such paper; and, to the end that the Commissioner may be fully informed on the subject, each applicant shall file with the register a sworn statement of all charges and fees paid by such applicant for publication and surveys, together with all fees and money paid the register and the receiver of the land office, which statement shall be transmitted, with the other papers in the case, to the Commissioner of the General Land Office.

Before appointment of a deputy is made he is required to file a bond of $10,000 for the faithful performance of his duties.

Upon receipt by the Surveyor-General of the application for survey order, together with the certified copy of location certificate and duplicate certificate of deposit for the necessary amount on account of office work, the application and copy of location certificates are examined on the following points:

Application for survey order must give—
Name of claimant.
Name of claim.

Name and address of deputy surveyor to whom order is to be sent.

Postoffice address of claimant, and must be signed by the claimant or his attorney; typewritten signatures will not be accepted.

The examination of the copy of the location certificate consists of:

A traverse of the boundary lines of the claim, which must close.

Claim must be tied to some permanent or fixed monument or so described that the locus of the claim can be determined (by giving section, or mining district in which claim is located).

The certificate must give—

Name of claim.

Name of locators.

Date of location.

Date and place (book and page) of record.

Certificate of county clerk regarding correctness of document which must contain his signature, seal and date.

All dates must be consistent.

In case of a lode claim the lode line must be described and must fit within the boundaries of the claim, and not be in excess of the statutory limit from any side line nor over 1500 ft. in length.

In case of placer claims, the acreage must be calculated and not over twenty acres allowed for each individual locator.

In case of mill sites not over five acres can be included in the exterior boundaries.

If these papers are correct, the order for survey is mailed to the deputy designated, who should then proceed to make the survey and return the field notes to the Surveyor-General prepared on the proper blanks, together with a plat of the claim prepared on tracing linen on a scale of 200 ft. to an inch.

The three blanks, title page, affidavit of Deputy and affidavit of assistants, are examined to see that they agree clerically with each other and with the application for survey order regarding names, dates, etc. This is done by the Chief Examiner who also examines the field notes for clerical errors, notes that all intersections with lines of conflicting surveys are properly given, that the area statement is complete, and that the improvements are properly described and actually benefit the claims to which they are credited.

The field notes are then taken up for examination on the connected sheets which are diagrams showing all approved mineral surveys. The sheet examination consists of platting the claim on this diagram, ascertaining that all conflicting approved surveys are shown in the field notes and that all such claims are shown in their correct positions. After passing the sheet examination the intersections, conflicting areas, lode line, etc., are then checked. Should at any stage errors be discovered in the field notes, they are returned to the Deputy Surveyor for correction, possibly many times, till the final draft is found to be correct. When all is found to be correct, the plat as approved and transcript of notes are prepared, and upon date of approval two copies of the plat and a transcript of the field notes are mailed to the claimant, or attorney, one copy of the plat mailed to the local land office, and one copy of the plat and the original field notes retained in office of Surveyor-General. The deputy is notified at date of approval of field notes.

The latest issue of Manual of Instructions is dated 1895 and many changes have been made since then in departmental practice, which changed conditions have, however, been met from time to time in the Mining Regulations issued by the General Land Office, that portion of which relating to Mineral Surveys, especially paragraphs 115 to 169 being given herewith.

36. The Surveyors-General should designate all surveyed mineral claims by a progressive series of numbers, beginning with Survey No. 37, irrespective as to whether they are situated on surveyed or unsurveyed lands, the claim to be so designated at date of issuing the order therefor, in addition to the local designation of the claim; it being required in all cases that the plat and field notes of the survey of a claim must, in addition to the reference to permanent objects in the neighborhood, describe the locus of the claim with reference to the lines of public surveys by a line connecting a corner of the claim with the nearest public corner of the United States surveys, unless such claim be on unsurveyed lands at a distance of more than two miles from such public corner, in which latter case it should be connected with a United States mineral monument. Such connecting line must not be more than two miles in length, and should be measured on the ground direct between the points, or calculated from actually surveyed traverse lines if the nature of the country should not permit direct measurement. If a regularly established survey corner is within two miles of a claim situated on unsurveyed lands, the connection should be made with such corner in preference to a connection with a United States mineral monument. The connecting line or traverse line must be surveyed by the Deputy Mineral Surveyor at the time of his making the particular survey, and be made a part thereof.

Placer Claims.

58. The proceedings to obtain patents for placer claims, including all forms of mineral deposits excepting veins of quartz or other rock in place, are similar to the proceedings prescribed for obtaining patents for vein or lode claims; but where a placer claim shall be upon surveyed lands, and conforms to legal subdivisions, no further survey or plat will be required. Where placer claims can not be con-

formed to legal subdivisions, survey and plat shall be made as on unsurveyed lands.

59. The proceedings for obtaining patents for veins or lodes having already been fully given, it will not be necessary to repeat them here, it being thought that careful attention thereto by applicants and the local officers will enable them to act understandingly in the matter, and make such slight modifications in the notice, or otherwise, as may be necessary in view of the different nature of the two classes of claims; placer claims being fixed, however, at two dollars and fifty cents per acre, or fractional part of an acre.

60. In placer applications for patent care must be exercised to determine the proper classification of the lands claimed. To this end the clearest evidence of which the case is capable should be presented.

(1) If the claim be all placer ground, that fact must be stated in the application and corroborated by accompanying proofs; if of mixed placers and lodes, it should be so set out, with a description of all known lodes situated within the boundaries of the claim. A specific declaration, such as is required by section 2333, Revised Statutes, must be furnished as to each lode intended to be claimed. All other known lodes are, by the silence of the applicant, excluded by law from all claim by him, of whatsoever nature, possessory or otherwise.

(2) Deputy surveyors shall, at the expense of the parties, make full examination of all placer claims surveyed by them, and duly note the facts as specified in the law, stating the quality and composition of the soil, the kind and amount of timber and other vegetation, the locus and size of streams, and such other matters as may appear upon the surface of the claim. This examination should include the character and extent of all surface and underground workings, whether placer or lode, for mining purposes.

(3) In addition to these data, which the law requires to

be shown in all cases, the Deputy should report with reference to the proximity of centers of trade or residence; also of well-known systems of lode deposit or of individual lodes. He should also report as to the use or adaptability of the claim for placer mining; whether water has been brought upon it in sufficient quantity to mine the same, or whether it can be procured for that purpose; and, finally, what works or expenditures have been made by the claimant or his grantors for the development of the claim, and their situation and location with respect to the same as applied for.

(4) This examination should be reported by the Deputy under oath to the Surveyor-General, and duly corroborated; and a copy of the same should be furnished with the application for patent to the claim, constituting a part thereof, and included in the oath of the applicant.

(5) Applications awaiting entry, whether published or not, must be made to conform to these regulations, with respect to examination as to the character of the land. Entries already made will be suspended for such additional proofs as may be deemed necessary in each case.

Mill Sites.

61. Land entered as a mill site must be shown to be non-mineral. Mill sites are simply auxiliary to the working of mineral claims, and as section 2337, which provides for the patenting of mill sites, is embraced in the chapter of the Revised Statutes relating to mineral lands, they are therefore included in this circular.

62. To avail themselves of this provision of law parties holding the possessory right to a vein or lode, and to a piece of non-mineral land not contiguous thereto for mining or milling purposes, not exceeding the quantity allowed for such purpose by section 2337, or prior laws, under which the land was appropriated, the proprietors of such vein or lode may file in the proper land office their application for

a patent, under oath, in manner already set forth herein, which application, together with the plat and field notes, may include, embrace, and describe, in addition to the vein or lode, such non-contiguous mill site, and after due proceedings as to notice, etc., a patent will be issued conveying the same as one claim. The owner of a patented lode may, by an independent application, secure a mill site if good faith is manifest in its use or occupation in connection with the lode and no adverse claim exists.

63. Where the original survey includes a lode claim and also a mill site the lode claim should be described in the plat and field notes as "Sur. No. 37, A," and the mill site as "Sur. No. 37, B," or whatever may be its appropriate numerical designation; the course and distance from a corner of the mill site to a corner of the lode claim to be invariably given in such plat and field notes, and a copy of the plat and notice of application for patent must be conspicuously posted upon the mill site as well as upon the vein or lode for the statutory period of sixty days. In making the entry no separate receipt or certificate need be issued for the mill site, but the whole area of both lode and mill site will be embraced in one entry, the price being five dollars for each acre and fractional part of an acre embraced by such lode and mill site claim.

64. In case the owner of a quartz mill or reduction works is not the owner or claimant of a vein or lode the law permits him to make application therefor in the same manner prescribed herein for mining claims, and after due notice and proceedings, in the absence of a valid adverse filing, to enter and receive a patent for his mill site at said price per acre.

65. In every case there must be satisfactory proof that the land claimed as a mill site is not mineral in character, which proof may, where the matter is unquestioned, consist of the sworn statement of two or more persons capable, from acquaintance with the land, to testify understandingly.

82. In order that the "boundaries" and "extent" of the claim may be shown, it will be incumbent upon the adverse claimant to file a plat showing his entire claim, its relative situation or position with the one against which he claims, and the extent of the conflict: Provided, however, That if the application for patent describes the claim by legal subdivisions, the adverse claimant, if also claiming by legal subdivisions, may describe his adverse claim in the same manner without further survey or plat. If the claim is not described by legal subdivisions, it will generally be more satisfactory if the plat thereof is made from an actual survey by a deputy mineral surveyor, and its correctness officially certified thereon by him.

91. With regard to the platting of the claim and other office work in the Surveyor's General office, that officer will make an estimate of the cost thereof, which amount the claimant will deposit with any assistant United States treasurer or designated depository in favor of the United States treasurer, to be passed to the credit of the fund created by "individual depositors for surveys of the public lands," and file with the Surveyor-General duplicate certificates of such deposit in the usual manner.

92. The Surveyors-General will endeavor to appoint surveyors to survey mining claims, so that one or more may be located in each mining district for the greater convenience of miners.

93. The usual oaths will be required of these surveyors and their assistants as to the correctness of each survey executed by them.

The duty of the surveyor ceases when he has executed the survey and returned the field notes and preliminary plat thereof with his report to the Surveyor-General. He will not be allowed to prepare for the mining claimant the papers in support of an application for patent, or otherwise perform the duties of an attorney before the land office in connection with a mining claim.

The Surveyors-General and local land officers are expected to report any infringement of this regulation to this office.

94. Should it appear that excessive or exorbitant charges have been made by any surveyor or any publisher, prompt action will be taken with the view of correcting the abuse.

Surveys of Mining Claims.

General Provisions.

115. Under section 2334, U. S. Rev. Stats., the U. S. Surveyor-General "may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appointment to survey mining claims."

116. Persons desiring such appointments should therefore file their applications with the Surveyor-General for the district wherein appointment is asked, who will furnish all information necessary.

117. All appointments of Deputy Mineral Surveyors must be submitted to the Commissioner of the General Land Office for approval.

118. The Surveyors-General have authority to suspend or revoke the commissions of Deputy Mineral Surveyors for cause. Before final action, however, the matter should be submitted to the Commissioner of the General Land Office for approval.

119. Such Surveyors will be allowed the right of appeal from the action of the Surveyor-General in the usual manner. Such appeal should be filed with the Surveyor-General, who will at once transmit the same, with a full report, to the General Land Office.

120. Neither the Surveyor-General nor the Commissioner of the General Land Office has jurisdiction to settle differences, relative to the payment of charges for field work, between Deputy Mineral Surveyors and claimants. These are matters of private contract and must be en-

forced in the ordinary manner, i. e., in the local courts. The Department has, however, authority to investigate charges affecting the official actions of Deputy Mineral Surveyors, and will, on sufficient cause shown, suspend or revoke their appointment.

121. The Surveyors-General should appoint as many competent Deputy Mineral Surveyors as apply for appointment, in order that claimants may have a choice of surveyors, and be enabled to have their work done on the most advantageous terms.

122. The schedule of charges for office work should be as low as is possible. No additional charges should be made for orders for amended surveys, unless the necessity therefor is clearly the fault of the claimant, or considerable additional office work results therefrom.

123. In cases where the error in the original survey is due to the carelessness or neglect of the Surveyor who made it, he should be required to make the necessary corrections in the field at his own expense, and the Surveyor-General should advise him that the penalty for failure to comply with instructions within a specified time will be the suspension or revocation of his commission.

124. Mineral Surveyors will address all official communications to the Surveyor-General. They will, when a mining claim is the subject of correspondence, give the name and survey number. In replying to letters they will give the subject-matter and date of the letter. They will promptly notify the Surveyor-General of any change in postoffice address.

125. Mineral Surveyors should keep a complete record of each survey made by them and the facts coming to their knowledge at the time, as well as copies of all their field notes, reports, and official correspondence, in order that such evidence may be readily produced when called for at any future time. Field notes and other reports must be written in a clear and legible hand or typewritten, in non-

copying ink, and upon the proper blanks furnished gratuitously by the Surveyor's General office upon application therefor. No interlineations or erasures will be allowed.

126. No return by a Mineral Surveyor will be recognized as official unless it is over his signature as a United States Deputy Mineral Surveyor, and made in pursuance of a special order from the Surveyor-General's office. After he has received an order for survey he is required to make the survey and return correct field notes thereof to the Surveyor-General's office without delay.

127. The claimant is required, in all cases, to make satisfactory arrangements with the Surveyor for the payment for his services and those of his assistants in making the survey, as the United States will not be held responsible for the same.

128. A Mineral Surveyor is precluded from acting, either directly or indirectly, as attorney in mineral claims. His duty in any particular case ceases when he has executed the survey and returned the field notes and preliminary plat, with his report, to the Surveyor-General. He will not be allowed to prepare for the mining claimant the papers in support of his application for patent, or otherwise perform the duties of an attorney before the Land Office in connection with a mining claim. He is not permitted to combine the duties of surveyor and notary public in the same case by administering oaths to the parties in interest, but as a notary public he may administer the oaths to his assistants in making the survey; otherwise he must have absolutely nothing to do with the case, except in his official capacity as Surveyor. He will make no survey of a mineral claim in which he holds an interest, nor will he employ chainmen interested therein in any manner.

Survey—How Made.

129. The survey made and returned must, in every case, be an actual survey on the ground in full detail, made by

the Mineral Surveyor in person after the receipt of the order, and without reference to any knowledge he may have previously acquired by reason of having made the location survey or otherwise, and must show the actual facts existing at the time. This precludes him from calculating the connections to corners of the public survey and location monuments, or any other lines of his survey through prior surveys made by others and substituting the same for connections or lines of the survey returned by him. The term survey in this paragraph applies not only to the usual field work, but also to the examinations required for the preparation of affidavits of five hundred dollars expenditure, descriptive reports on placer claims, and all other reports.

130. The survey of a mining claim may consist of several contiguous locations, but such survey must, in conformity with statutory requirements, distinguish the several locations, and exhibit the boundaries of each. The survey will be given but one number.

131. The survey must be made in strict conformity with, or be embraced within, the lines of the location upon which the order is based. If the survey and location are identical, that fact must be clearly and distinctly stated in the field notes. If not identical, a bearing and distance must be given from each established corner of survey to the corresponding corner of the location, and the location corner must be fully described, so that it can be identified. The lines of the location, as found upon the ground, must be laid down upon the preliminary plat in such a manner as to contrast and show their relation to the lines of survey.

132. In view of the principle that courses and distances must give way when in conflict with fixed objects and monuments, the surveyor will not, under any circumstances, change the corners of the location for the purpose of making them conform to the description in the record. If the

difference from the location be slight, it may be explained in the field notes.

133. No mining claim located subsequent to May 10, 1872, should exceed the statutory limit in width on each side of the center of vein or 1,500 feet in length, and all surveys must close within 50-100 feet in 1,000 feet, and the error must not be such as to make the location exceed the statutory limit, and in absence of other proof the discovery point is held to be the center of the vein on the surface. The course and length of the vein should be marked upon the plat.

134. All mineral surveys must be made with a transit, provided with a solar attachment, by which the meridian can be determined independently of the magnetic needle, and all courses must be referred to the true meridian. The variation should be noted at each corner of the survey. The true course of at least one line of each survey must be ascertained by astronomical observations made at the time of the survey; the data for determining the same and details as to how these data were arrived at must be given. Or, in lieu of the foregoing the survey must be connected with some line the true course of which has been previously established beyond question, and in a similar manner, and, when such lines exist, it is desirable in all cases that they should be used as a proof of the accuracy of subsequent work.

135. Corner No. 1 of each location embraced in a survey must be connected by course and distance with nearest corner of the public servey or with a United States location monument, if the claim lies within two miles of such corner or monument. If both are within the required distance the connection must be with the corner of the public survey.

136. Surveys and connections of mineral claims may be made in suspended townships in the same manner as though the claims were upon unsurveyed land, except as

hereinafter specified, by connecting them with independent mineral monuments. At the same time, the position of any public-land corner which may be found in the neighborhood of the claim should be noted, so that, in case of the release of the township from suspension, the position of the claim can be shown on the plat.

137. A mineral survey must not be returned with its connection made only with a corner of the public survey, where the survey of the township within which it is situated is under suspension, nor connected with a mineral monument alone, when situated within the limits of a township the regularity and correctness of the survey of which is unquestioned.

138. In making an official survey, corner No. 1 of each location must be established at the corner nearest the corner of the public survey or location monument, unless good cause is shown for its being placed otherwise. If connections are given to both a corner of the public survey and location monument, corners Nos. 1 should be placed at the corner nearest the corner of the public survey. When a boundary line of a claim intersects a section line courses and distances from point of intersection to the government corners at each end of the half mile of section line so intersected must be given.

139. In case a survey is situated in a district where there are no corners of the public survey and no monuments within the prescribed limits, a mineral monument must be established, in the location of which the greatest care must be exercised to insure permanency as to site and construction.

140. The site, when practicable, should be some prominent point, visible for a long distance from every direction, and should be so chosen that the permanency of the monument will not be endangered by snow, rock, or landslides, or other natural causes.

141. The monument should consist of a stone not less

than 30 inches long, 20 inches wide, and 6 inches thick, set halfway in the ground, with a conical mound of stone 4 feet high and 6 feet base alongside. The letters U. S. L. M., followed by the consecutive number of the monument in the district, must be plainly chiseled upon the stone. If impracticable to obtain a stone of required dimensions, then a post 8 feet long, 6 inches square, set 3 feet in the ground, scribed as for a stone monument, protected by a well-built conical mound of stone of not less than 3 feet high and 6 feet base around it, may be used. The exact point for connection must be indicated on the monument by an X chiseled thereon; if a post is used, then a tack must be driven into the post to indicate the point.

142. From the monument, connections by course and distance must be taken to two or three bearing trees or rocks, and to any well-known and permanent objects in the vicinity, such as the confluence of streams, prominent rocks, buildings, shafts, or mouths of adits. Bearing trees must be properly scribed B. T. and bearing rocks chiseled B. R., together with the number of the location monument; the exact point on the tree or stone to which the connection is taken should be indicated by a cross or other unmistakable mark. Bearings should also be taken to prominent mountain peaks, and the approximate distance and direction ascertained from the nearest town or mining camp. A detailed description of the locating monument, with a topographical map of its location, should be furnished the office of the Surveyor-General by the surveyor.

143. Corners may consist of—

First.—A stone at least 24 inches long set 12 inches in the ground, with a conical mound of stone 1½ feet high, 2 feet base, alongside.

Second.—A post at least 3 feet long by 4 inches square, set 18 inches in the ground and surrounded by a substantial mound of stone or earth.

Third.—A rock in place.

A stone should always be used for a corner when possible, and when so used the kind should be stated.

144. All corners must be established in a permanent and workmanlike manner, and the corner and survey number must be neatly chiseled or scribed on the sides facing the claim. The exact corner point must be permanently indicated on the corner. When a rock in place is used its dimensions above ground must be stated and a cross chiseled at the exact corner point.

145. In case the point for the corner be inaccessible or unsuitable a witness corner, which must be marked with the letters W. C. in addition to the corner and survey number, should be established. The witness corner should be located upon a line of the survey and as near as possible to the true corner, with which it must be connected by course and distance. The reason why it is impossible or impracticable to establish the true corner must always be stated in the field notes, and in running the next course it should be stated whether the start is made from the true place for corner or from witness corner.

146. The identity of all corners should be perpetuated by taking courses and distances to bearing trees, rocks, and other objects, as prescribed in the establishment of location monuments, and when no bearings are given it should be stated that no bearings are available. Permanent objects should be selected for bearings whenever possible.

147. If an official mineral survey has been made in the vicinity, within a reasonable distance, a further connecting line should be run to some corner thereof; and in like manner all conflicting surveys and locations should be so connected, and the corner with which connection is made in each case described. Such connections will be made and conflicts shown according to the boundaries of the neighboring or conflicting claims as each is marked, defined, and actually established upon the ground. The mineral surveyor will fully and specifically state in his return how and

by what visible evidences he was able to identify on the ground the several conflicting surveys and those which appear according to their returned tie or boundary lines to conflict, if they were so identified, and report errors or discrepancies found by him in any such surveys. In the survey of contiguous claims which constitute a consolidated group, where corners are common, bearings should be mentioned but once. (Amendment.)

148. The mineral surveyor should note carefully all topographical features of the claim, taking distances on his lines to intersections with all streams, gulches, ditches, ravines, mountain ridges, roads, trails, etc., with their widths, courses, and other data that may be required to map them correctly. All municipal or private improvements, such as blocks, streets, and buildings, should be located.

149. If, in running the exterior lines of a claim, the survey is found to conflict with the survey of another claim, the distances to the points of intersection, and the courses and distances along the line intersected from an established corner of such conflicting claim to such points of intersection, should be described in the field notes: Provided, That where a corner of the conflicting survey falls within the claim being surveyed, such corner should be selected from which to give the bearing, otherwise the corner nearest the intersection should be taken. The same rule should govern in the survey of claims embracing two or more locations the lines of which intersect.

150. A lode and mill-site claim in one survey will be distinguished by the letters A and B following the number of the survey. The corners of the mill site will be numbered independently of those of the lode. Corner No. 1 of the mill site must be connected with a corner of the lode claim as well as with a corner of the public survey or United States location monument.

151. When a placer claim includes lodes, or when several contiguous placer or lode locations are included as one

claim in one survey, there must be given to the corners of each location constituting the same a separate consecutive numerical designation, beginning with corner No. 1 in each case.

152. Throughout the description of the survey, after each reference to the lines or corners of a location, the name thereof must be given, and if unsurveyed, the fact stated. If reference is made to a location included in a prior official survey, the survey number must be given, followed by the name of the location. Corners should be described once only.

153. The total area of each location and also the area in conflict with each intersecting survey or claim should be stated; also the total area claimed. But when locations embraced in one survey conflict with each other such conflicts should only be stated in connection with the location from which the conflicting area is excluded.

154. It should be stated particularly whether the claim is upon surveyed or unsurveyed public lands, giving in the former case the quarter section, township, and range in which it is located, and the section lines should be indicated by full lines and the quarter-section lines by dotted lines.

155. The title-page of the field notes must contain the postoffice address of the claimant or his authorized agent.

156. In the mineral surveyor's certificate of the value of the improvements all actual expenditures and mining improvements made by the claimant or his grantors, having a direct relation to the development of the claim, must be included in the estimate.

157. The expenditures required may be made from the surface or in running a tunnel, drifts, or crosscuts for the development of the claim. Improvements of any other character, such as buildings, machinery, or roadways, must be excluded from the estimate, unless it is shown clearly that they are associated with actual excavations.

such as cuts, tunnels, shafts, etc., are essential to the practical development of, and actually facilitate the extraction of mineral from, the claim.

158. All mining and other improvements claimed will be located by courses and distances from corners of the survey, or from points on the center or side lines, specifying with particularity and detail the dimensions and character of each, and the improvements upon each location should be numbered consecutively, the point of discovery being always No. 1. Improvements made upon other locations, or by a former locator who has abandoned the claim, can not be included in the estimate, but should be described and located in the notes and plat.

159. In case of a lode and mill-site claim in the same survey the expenditure of five hundred dollars must be shown upon the lode claim.

160. If the value of the labor and improvements upon a mineral claim is less than five hundred dollars at the time of survey, the mineral surveyor may file with the Surveyor-General supplemental proof showing five hundred dollars expenditure made prior to the expiration of the period of publication.

161. The mineral surveyor will return with his field notes a preliminary plat on blank sent to him for that purpose, protracted on a scale of two hundred feet to an inch, if practicable. In preparing plats the top is north. Copy of the calculations of areas by double meridian distances and of all triangulations or traverse lines must be furnished. The lines of the claim surveyed should be heavier than the lines of conflicting claims.

162. Whenever a survey has been reported in error the surveyor who made it will be required to promptly make a thorough examination upon the premises and report the result, under oath, to the Surveyor-General's office. In case he finds his survey in error he will report in detail all discrepancies with the original survey and submit any ex-

planation he may have to offer as to the cause. If, on the contrary, he should report his survey correct, a joint survey will be ordered to settle the differences with the surveyor who reported the error. A joint survey must be made within ten days after the date of order unless satisfactory reasons are submitted, under oath, for a postponement. The field work must in every sense of the term be a joint and not a separate survey, and the observations and measurements taken with the same instrument and chain, previously tested and agreed upon.

163. The surveyor found in error, or, if both are in error, the one who reported the same, will make out the field notes of the joint survey, which, after being duly signed and sworn to by both parties, must be transmitted to the Surveyor-General's office.

164. Inasmuch as amended surveys are ordered only by special instructions from the General Land Office, and the conditions and circumstances peculiar to each separate case, and the object sought by the required amendment, alone govern all special matters relative to the manner of making such survey and the form and subject-matter to be embraced in the field notes thereof, but few general rules applicable to all cases can be laid down.

165. The amended survey must be made in strict conformity with, or be embraced within, the lines of the original survey. If the amended and original surveys are identical, that fact must be clearly and distinctly stated in the field notes. If not identical, a bearing and distance must be given from each established corner of the amended survey to the corresponding corner of the original survey. The lines of the original survey, as found upon the ground, must be laid down upon the preliminary plat in such manner as to contrast and show their relation to the lines of the amended survey.

166. The field notes of the amended survey must be prepared on the same size and form of blanks as are the field

notes of the original survey, and the word "amended" must be used before the word "survey" wherever it occurs in the field notes.

167. Mineral surveyors are required to make full examinations of all placer claims at the time of survey and file with the field notes a descriptive report, in which will be described—

(a) The quality and composition of the soil, and the kind and amount of timber and other vegetation.

(b) The locus and size of streams, and such other matter as may appear upon the surface of the claims.

(c) The character and extent of all surface and underground workings, whether placer or lode, for mining purposes, locating and describing them.

(d) The proximity of centers of trade or residence.

(e) The proximity of well-known systems of lode deposits or of individual lodes.

(f) The use or adaptability of the claim for placer mining and whether water has been brought upon it in sufficient quantity to mine the same, or whether it can be procured for that purpose.

(g) What works or expenditures have been made by the claimant or his grantors for the development of the claim, and their situation and location with respect to the same as applied for.

(h) The true situation of all mines, salt licks, salt springs, and mill sites which come to the surveyor's knowledge, or a report by him that none exist on the claim, as the facts may warrant.

(i) Said report must be made under oath and duly corroborated by one or more disinterested persons.

168. The employing of claimants, their attorneys, or parties in interest, as assistants in making surveys of mineral claims, will not be allowed.

169. The field work must be accurately and properly performed and returns made in conformity with the fore-

going instructions. Errors in the survey must be corrected at the surveyor's own expense, and if the time required in the examination of the returns is increased by reason of neglect or carelessness, he will be required to make an additional deposit for office work. He will be held to a strict accountability for the faithful discharge of his duties, and will be required to observe fully the requirements and regulations in force as to making mineral surveys. If found incompetent as a surveyor, careless in the discharge of his duties, or guilty of a violation of said regulations, his appointment will be promptly revoked.

W. A. RICHARDS,
Commissioner.

Approved.
E. A. HITCHCOCK, Secretary.

The surveyor general of Colorado has issued the following circular letter and requires deputy mineral surveyors to comply strictly therewith:

In your future work before this office you will comply in detail with the requirements contained in amended paragraph 147 of Mining Circular, and to insure uniformity in your returns will pay particular attention to the following instructions:

As said amendment requires that all conflicting surveys shall be shown according to the boundaries as each is marked, defined and actually established upon the ground without regard to whether or not patents have issued for the claims in question; you will be required to determine in each case that the monuments of conflicting claims as found upon the ground are the official monuments of the official surveys, or occupy the original position of the same. If this cannot be determined it will then be necessary to revert to the record and show said claims in their approved and patented positions.

A strict compliance with paragraph 149 of the Mining Circular, which is in part as follows, will be required:

"If in running the exterior lines of a claim the survey is found to conflict with the survey of another claim, the distances to the points of intersection and the courses and distances along the line intersects from an established corner of such conflicting claim to such points of intersection, should be described in the field notes." . . . . . .

This will necessitate the re-running by you of each line of a conflicting survey which intersects the exterior lines of the claim being surveyed; and a report upon the course, and if necessary, the length of the same.

The section and quarter section in which a survey is located will be determined, assuming the subdivision field notes as returned by the deputy surveyor to be correct.

You will further be required in the field notes, when connections are given to a conflicting or neighboring survey, to state whether or not said connection is given to the position of the claim as staked or as approved by this office.

An additional note added at the end of the field notes, under heading "Report," will be required, stating:

1st. How the lines of the survey, connections to conflicting surveys and to the corner of the public survey or U. S. Location Monument, were determined.

2nd. A description of the section corner or U. S. Location Monument to which connection is given in the field notes.

3rd. A full description of all corners of conflicting claims to which connections are given in the field notes, together with a statement of how and by what visible evidence you were able to identify the same as being the official monuments of the claim in question.

4th. A statement showing how the courses and lengths of the intersecting boundary lines of conflicting surveys were determined.

The following circular letter is also of interest:

DEPARTMENT OF THE INTERIOR,
Office of
United States Surveyor General, for the District of Colorado.
Denver, Colo., May 25, 1892.

To Applicants for Mineral Survey Orders
in the District of Colorado:

You are informed that in numerous cases the certified copies of location certificates filed in this office with applications for mineral survey orders are so defective that orders cannot be based thereon. This is a very important matter, and locators cannot exercise too much care in defining their locations at the outset, inasmuch as the act of Congress of May 10, 1872, provides "That all records of mining claims hereafter made shall contain the name or names of the locators, the date of location, and such a description of the claim or claims located by reference to some natural object or permanent monument as will identify the claim."

It is also provided by the General Statutes of Colorado, section 2400, that "Any location certificate of a lode claim which shall not contain the name of the lode, the name of the locator, the date of location, the number of lineal feet claimed on each side of the discovery shaft, the general course of the lode and such description as shall identify the claim with reasonable certainty, shall be void."

One or more of these requirements is often omitted in location certificates submitted to this office, and you are therefore advised, before filing your application, to see that your location has been made in conformity with law and regulations, and that the claim for which patent is sought is properly described.

A fruitful source of delay is the failure of applicants, their agents or attorneys to thoroughly examine the copies of location certificates received from the county clerk, comparing the same with the original, to see that clerical

errors have been avoided. The discovery of such errors in this office necessitates the return of the document for correction; causes delay in the issuance of the order for survey and, by allowing the intervention of other orders with prior numbers, retards the approval of the survey often for many weeks. You are therefore requested before filing a copy of a location certificate in this office to examine the same carefully and see:

That the distances given each way from the discovery do not aggregate more than 1,500 feet, and equal the length of the claim along the vein, as determined from the description by metes and bounds thereof. That not more than the statutory limit is claimed on either side of the discovery,* that the discovery is not described in one place as a shaft and in another as a cut or tunnel; that the end lines are parallel; that the courses and distances given as the boundaries of the claim close; that the dates are correct and consistent; that the name of the claim is legibly written; that the certificate of the county clerk is properly sealed, dated, signed, correctly gives the name of the claim and designates the instrument, as a location, amended, additional or relocation certificate, as the case may be. The importance of attending to these details in the matter of location will be the more readily perceived when it is understood that a failure to give the subject proper attention may invalidate the claim.

E. C. HUMPHREY,
United States Surveyor General for Colorado.

---

*Note.—Colorado Statutes, Section 2398: The width of lode claims hereafter located in Gilpin, Clear Creek, Boulder and Summit counties, shall be seventy-five feet on each side of the center of the vein or crevice; and in all other counties the width of the same shall be one hundred and fifty feet on each side of the center of the vein or crevice.

Records.

As the deputy surveyor and others are constantly required to consult the records on file in the surveyor's general office, it will be well to give an account of the methods used in the Colorado office:

All claims are indexed alphabetically and numerically. In the alphabetical index there is no information except the name of the claim, its number and land district. In the numerical index is given the number of the claim, the name or names, the claimant, surveyor, date of filing, plat book number, field book number, date of patent or cancellation, township and section, and, under remarks, any further information. The plat books, of which there are over two hundred at present, each contain about one hundred facsimilies of the plats of approved claims. These plats show at a glance the position of the claim and its conflicts, the net area being colored, conflicts, ties, intersections, improvements, etc., and are probably the most consulted by those desiring information. For additional information the bound field notes filed by the deputy surveyor are used. In addition, all correspondence with the General Land Office if any, is kept on file and may be consulted if required. The so-called connected sheets embrace each a square mile on which all claims in the area embraced are platted on a scale of 300 feet to the inch. Notes from any of these records may be made by any one interested or entitled to information, or copies certified or otherwise will be made in the surveyor's general office for a nominal fee.

The deputy surveyor as a rule finds it necessary to keep a complete record of the claims in his district for the benefit of his clients, and is required by the General Land Office to keep a complete record of all official work done by himself. In this way every deputy's office is a more or less complete reproduction of the surveyor's general

office in miniature as far as his own district is concerned. The writer's method of keeping records is as follows:

The card catalog system is employed throughout where possible. Each claim is catalogued alphabetically on cards, (with a number of names of claims on each card), and also catalogued numerically with one number to each card. This latter card contains data as follows:

Sur. No. 16721. Name Silver Star.
Surveyor John Smith. Date March 20, 1903.
Notes Scrap Book 101. Plats Vol. 12.
Maps
N.W. Sec. 31, T. 3 S. R. 73 W. Patent June 20, 1905.
District Montana.
Claimant Henry Jones.
Area 5.045 acres.
Remarks

These constitute the index cards.

The skeleton field notes, an example of which is given below, are also copied on a card which is catalogued numerically. (These should contain the metes and bounds of the claim, the section ties and ties to other claims, and it is well to have a note of the corners, whether they be stones, posts, etc.):

16721	Silver Star.			
1	S. E. 25–3–74 N. 38° 51′ W. 1961.7			
1–2	S. 50° 30′ E.	150	1 =	stone
2–3	S. 30° 30′ W.	1500	2 =	tree
3–4	N. 50° 30′ W.	150	3 =	stone
4–1	N. 30° 30′ E.	1500	4 =	stone
1–6–15950	Golden lode	= N. 5° 38′ E.		20.6
3–2– 1820	Bear lode	= N. 30° 10′ W.		75.8

The cards have all the advantages common to the card system in general and also the advantage over books that several people can work in the same office without getting into each other's way by wanting the same volume of

notes at the same time, or having to copy the notes desired out of a book. Then, too, the cards can be taken into the field, and thus copying of notes is avoided. While the skeleton field notes of old claims have to be copied, in the case of new claims the published notes of the claim are simply pasted on the cards, after checking, and afterwards any further information likely to be required is added. The official plats of the claim are also copied and bound up in plat books in every way similar to those in the surveyor's general office, but as a rule without the intersections. On these plats the areas actually patented are colored.

The carbon copies of all field notes made or acquired are bound together. In addition the connected sheets for these sections required in the Clear Creek and Gilpin districts have been copied in the surveyor's general office and transferred to protractor sheets exactly like those used in that office.

In order to give an idea of larger areas of country than that given by one section, another set of maps is also made up where nine sections are combined on one sheet and the claims colored to show at a glance what area each has patented. These sheets of nine square miles each are arranged in a roller map case.

Field note books are paged consecutively and card catalogued. Thus in the system used, page 1213 means note book, volume 12, page 13.

All figuring is done on sheets of paper of equal size, and filed, each claim by itself, in congress envelopes.

Carbon copies of all location certificates are filed in an arch letter file.

The Globe-Wernicke and similar filing cabinets afford the best means of preserving these various devices, with the exception of the large plats.

The connected sheets are kept in a case made especially for them.

CHAPTER VIII.

Examination for Commission as U. S. Deputy Mineral Surveyor.

This examination in Colorado consists of problems in calculation of closing line in a twelve or thirteen-sided placer, together with calculation of area by Double Meridian Distance Method, calculation of lode line to fit an irregular claim, calculation of ties, intersections and areas in an actual approved survey together with writing up a complete set of field notes. A problem on the subdivision of a section of the public survey is usually added. The applicant is also required to determine a correct meridian from solar observation and must do this with his own transit. There are of course other problems, but they in no way differ from those numerous examples that have been given and explained in the course of this work. A few examples will, however, be given in detail to illustrate special cases. One favorite problem which is of considerable importance is the one first mentioned above and is as follows:

Placer Calculations.

Given: The courses and lengths of lines 1 to 13 of a certain placer. (Fig. 34.) It is desired to amend the survey making Cors. Nos. 2 and 12 identical with the corners of the original survey, the courses of lines 1-2 and 12-13 to remain the same, and the course of line 13-1 to be S. 33° 34' E., the new placer to contain an area of 35 acres. Required, the lengths of lines 12-13 and 1-2.

In figuring the missing course and distance of line 13-1, reference should be made to the latitudes and departures

Station.	Course.	Distance.	Latitudes North.	Latitudes South.	Departures East.	Departures West.	D. M D	N. Areas.	S. Areas.
1-2	S 87° 19′ W.	1108.73	.....	51.91	.....	1107.51	1107.51	.....	57490.83
2-3	N 67° 50′ W.	303.50	114.51	.....	.....	281.07	2496.09	285827.20	.....
3-4	N 77° 35′ W.	297.00	63.86	.....	.....	290.05	3067.21	195872.00	.....
4-5	S 28° 36′ W.	796.10	.....	698.96	.....	381.09	3738.35	.....	2612956.90
5-6	N 19° 56′ W.	905.00	850.78	.....	.....	308.54	4427.98	3767236.90	.....
6-7	N 77° 35′ W.	145.00	31.18	.....	.....	141.61	4878.13	152100.10	.....
7-8	N 18° 41′ E.	512.00	485.02	.....	164.01	.....	4855.73	2355125.54	.....
8-9	S 71° 08′ E.	962.00	.....	311.08	910.32	.....	3781.40	.....	1176317.89
9-10	S 53° 05′ E.	537.60	.....	322.91	429.82	.....	2441.26	.....	788307.45
10-11	S 88° 42′ E.	718.50	.....	16 30	718.32	.....	1293.12	.....	21077.71
11-12	N 17° 40′ W.	633.00	603.15	.....	.....	192 10	766.90	462555.61	.....
12-13	N 70° 21′ E.	259.04	87.11	.....	243.95	.....	715.05	62288.00	.....
13-1	S 15° 46′ E.	867.97	.....	834.45	235.55	.....	235.55	.....	196554.71
			2235.61	2235.61	2701 97	2701 97		7281005.35	4852705.49
								4852705.49	
								2)2428299.86	
								1214149.93 sq. ft.	

log 1214149.93 = 6.0842721
log 43560 = 4,6390879

log 27.873 = 1.4451842

of courses 1 to 13, included in computing the area by Double Meridian Distances.

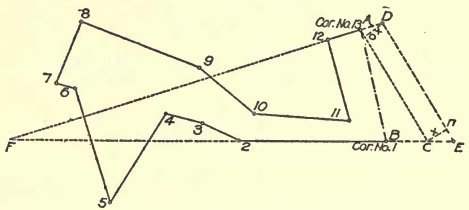


Fig. 34.

The sum of the north latitudes is found to be 2235.61, and the sum of the south latitudes is found to be 1401.16, which latter subtracted from the north latitudes leaves a north latitude of 834.45. In like manner subtracting the sum of the east departures, 2466.42, from the sum of the west departures, 2701.97, leaves a west departure of 235.55.

log	834.45 = 2.9214003	log	834.45 = 2.9214003
log	235.55 = 2.3720831	log cos	15° 46′ = 9.9833449
log cotan	15° 46′ = 0.5493172	log	867.07 = 2.9380554

Missing course = S 15° 46′ E 867.07 ft.

In the triangle ABC draw AC parallel to DE, whose course is given as S. 33° 34′ E. Line AB we have found to be S. 15° 46′ E. 867.07 feet.

					A = 17° 48′
A = 33° 34′	B = 87° 19′	C = 33° 34′	180° 00′		B = 103° 05′
15° 46′	15° 46′	87° 19′	120° 53′		C = 59° 07′
17° 48′	103° 05′	120° 53′	59° 07′		180° 00′

sin 59° 07′ : 867.07 = sin 103° 05′ : ?
sin 59° 07′ : 867.07 = sin 17° 48′ : ?

log	867.07 = 2.938054	log	867.07 = 2.938054
log sin	103° 05′ = 9.988578	log sin	17° 48′ = 9.485289
colog sin	59° 07′ = 0.066404	colog sin	59° 07′ = 0.066404
log	984.09 = 2.993036	log	308.85 = 2.489747

Area = ½ (867.07×308.85×sin 103° 05′)

log	867.07 = 2.938054
log	308.85 = 2.489747
log sin	103° 05′ = 9.988578
colog	87120 = —5.059882
log	2.994 = 0.476261

Construct the triangle ACF. Line AF is a prolongation of line 12-13, and line CF is a prolongation of line 1-2.

				A =	103° 55′
A =	70° 21′	C = 33° 34′	180° 00′	F = 87° 19′	C = 59° 07′
	33° 34′	87° 19′	120° 53′	70° 21′	F = 16° 58′
	103° 55′	120° 53′	59° 07′	16° 58′	180° 00′

sin 16° 58′ : 984.09 = sin 103° 55′ : ?
sin 16° 58′ : 984.09 = sin 59° 07′ : ?

log	984.09 = 2.993035	log	984.09 = 2.993035
log sin	103° 55′ = 9.987061	log sin	59° 07′ = 9.933596
colog sin	16° 58′ = 0.534892	colog sin	16° 58′ = 0.534892
log	3273.32 = 3.514988	log	2894.17 = 3.461523

Area = ½ (984.09×2894.17×sin 103° 55′)

log	984.09 = 2.993035
log	2894.17 = 3.461524
log sin	103° 55′ = 9.987061
colog	87120 = —5.059882
log	31.732 = 1.501502

The area of the placer was found to be 27.873 acres. The area of the quadrilateral ADBE is therefore the difference between 35 acres, the required acreage, and 27.873

acres, which is 7.127 acres. The area of the triangle ABC was found to be 2.994 acres; then the area of the quadrilateral ADCE is the difference between 7.127 acres and 2.994 acres, or 4.133 acres. The area of the triangle ACF has been found to be 31.732 acres. Therefore the area of the triangle DEF is 31.732 acres + 4.133 acres, or 35.865 acres.

By geometry

$31.732 : 984.09^2 = 35.865 : DE^2$
$31.732 : 3273.32^2 = 35.865 : EF^2$
$31.732 : 2894.17^2 = 35.865 : DF^2$

log	$984.09^2 = 5.986070$	log	$3273.32^2 = 7.029978$
log	$35.865 = 1.554671$	log	$35.865 = 1.554671$
	7.540741		8.584649
log	$31.732 = 1.501502$	log	$31.732 = 1.501502$
	2) 6.039239		2) 7.083147
log	$1046.21 = 3.019619$	log	$3479.95 = 3.541573$

log	$2894.17^2 = 6.923046$		$DF = 3076.86$
log	$35.865 = 1.554671$		$AF = 2894.17$
	8.477717		$AD = 182.69$
log	$31.732 = 1.501502$		
			$EF = 3479.95$
	2) 6.976215		$CF = 3273.32$
log	$3076.86 = 3.488107$		$EC = 206.63$

$BC = 308.85$	$1\text{-}2 = 1108.73$	$12\text{-}13 = 259.04$
$EC = 206.63$	$BE = 514.48$	$AD = 182.69$
$BE = 514.48$	$E\text{-}2 = 1623.21$	$12\text{-}D = 441.73$

Another method of working this problem is as follows: The area of the quadrilateral ADCE has been found as in the previous figuring. The following formula will give the altitude:

Let x = altitude
Let K = cot E — cot A
Let A = area of ADCE (4.135 acres = 180,033 sq. ft.)
Let D = 984.09 ft., (line AC)

$$x = \frac{1}{K}\left(\pm\sqrt{2AK+D^2}-D\right)$$

nat cot 59° 07′ = .59809	log 984.09 = 2.9930348
nat cot 76° 05′ = .24778	log to square = 2.9930348
K = .35031	log 968433.12 = 5.9860696

$$x = \frac{1}{.35031}\left(\sqrt{2\times180033\times.35031+968433.12}-984.09\right)$$

log 200 =	0.3010300	126135.00
log 180033.00 =	5.2553533	D^2 = 968433.12
log 0.35031 =	—1.5444525	1094678.12
log 126,135 =	5.1008358	

The square root of 1,094,678.12 is found as follows:

log 1094678.12 = 6.0392436	1046.21
2)6.0392436	984.09
3.0196218 = log 1046.21	62.12

log 62.12 = 1.793231
log .35031 = —1.544452

log 177.33 = 2.248779 = x

In the right triangle ADo, we have Do = 177.33 feet, the angle D = 70° 21′ — 56° 26′ = 13° 55′.

log 177.33 = 2.248779	log 177.32 = 2.248779
log tan 13° 55′ = 9.394073	log cos 13° 55′ = 9.987061
log 43.94 = 1.642852	log 182.69 = 2.261718

It is seen here that line AD, 182.69, checks with the former work.

In the right triangle CEn, we have Cn = 177.33 feet, and the angle E = 39° 07′.

log	177.33 = 2.248779	log	177.33 = 2.248779
log cot	59° 07′ = 9.776769	log sin	59° 07′ = 9.933596
log	106.06 = 2.025548	log	206.62 = 2.315183

Line CE, 206.62, also checks line CE in the first method.

984.09 = AC
43.94 = Ao

940.15 = oC = Dn
106.06 = nE

1046.21 = DE

Calculation of Lode Line.

Given the boundaries of a claim, calculate a lode line parallel to the side lines, and the points at which the lode line intersects the end lines. No point on the lode line to be in excess of 150 feet from either side line. Lode line to be 1,500 feet long.

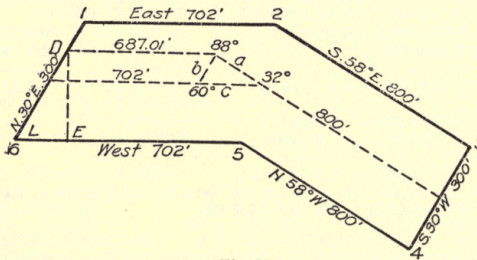


Fig. 35.

The boundaries are as follows: Beginning at Cor. No. 1, thence E. 702 ft. to Cor. No. 2; thence S. 58° E. 800 ft. to Cor. No. 3; thence S. 30° W. 300 ft. to Cor. No. 4; thence N. 58° W. 800 ft. to Cor. No. 5; thence W. 702 ft. to Cor. No. 6; thence N. 30° E. 300 ft. to Cor. No. 1, the

place of beginning. (See Fig. 35, which shows conditions necessarily greatly exaggerated.) The side b is drawn parallel to the end lines in the triangle whose sides are a, b and c.

$$800+a+702-c=1500$$
$$1502+a-c=1500$$
$$c-a=2$$

$$c=\frac{a \sin 88^\circ}{\sin 60^\circ}$$

$$\frac{a \sin 88^\circ}{\sin 60^\circ}-a=2$$

$$a \sin 88^\circ - a \sin 60^\circ = 2 \sin 60^\circ$$

$$a=\frac{2 \sin 60^\circ}{\sin 88^\circ - \sin 60^\circ}$$

$\sin 60^\circ = .86603$
2
1.73206

$\log 1.73206 = 0.238698$
$\log .13336 = -1.125025$
$\log 12.99 = 1.113673$

$\sin 88^\circ = .99939$
$\sin 60^\circ = .86603$
$.13336$

In the triangle whose side a we have found to be 12.99, the sides b and c are found as follows:

$\sin 60^\circ : 12.99 = \sin 32^\circ : ?$
$\sin 60^\circ : 12.99 = \sin 88^\circ : ?$

$\log 12.99 = 1.113673$
$\log \sin 32^\circ = 9.724210$
$\operatorname{colog} \sin 60^\circ = 0.062469$
$\log 7.95 = 0.900352$

$\log 12.99 = 1.113673$
$\log \sin 88^\circ = 9.999735$
$\operatorname{colog} \sin 60^\circ = 0.062469$
$\log 14.99 = 1.175877$

$800+12.99+702-14.99=1500=$ lode line

800.	702.	687.01
12.99	14.99	812.99
812.99	687.01	1500.00

The distance of the lode line at its intersection with line 6-1 is found to be 157.95 feet from Cor. No. 6, and 142.05 feet from Cor. No. 1, by adding the distance 7.95 feet (b) in one case, and subtracting in the other, to and from 150 feet.

In the triangle DEL draw DE perpendicular to the side line. Multiplying the side LD (157.95) by the sine of the angle L, 60°, we get the distance of the lode line from line 5-6, which is 136.80 feet.

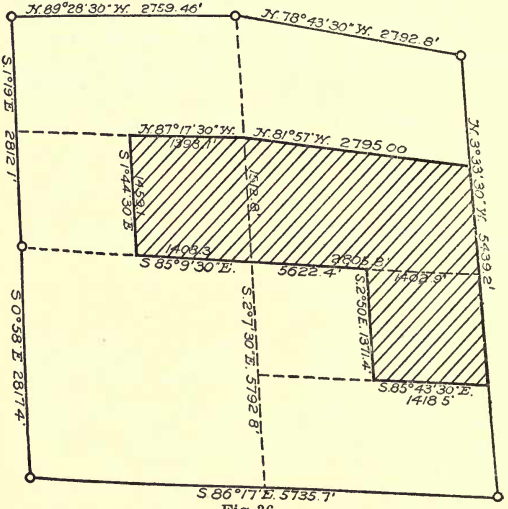


Fig 36.

Subdivision of Section.

Given the boundaries of a section (Fig. 36) to determine the boundaries of the S.E. ¼ of the N.W. ¼, the S. ½ of the N.E. ¼ and the N.E. ¼ of the S.E. ¼ sections.

S. 86° 17′	E.	5735.7	feet.
N. 3° 33′ 30″	W.	5439.2	feet.
N. 78° 43′ 30″	W.	2792.8	feet.
N. 89° 28′ 30″	W.	2759.46	feet.
S. 1° 19′	E.	2812.1	feet.
S. 0° 58′	E.	2817.4	feet.

General Figuring.

In Fig. 37 we have an example of a problem given the writer in his examination for a commission as United States Deputy Mineral Surveyor. Given the data shown in the figure, calculate boundaries of St. Louis Lode, (cut-

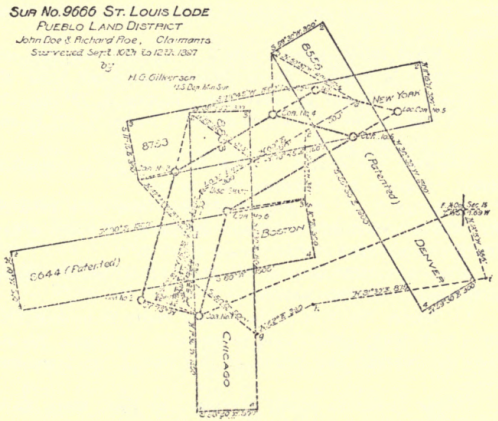


Fig. 37.

ting off at intersection of end line with Sur. No. 8556 Denver Lode), section tie directly, ties to conflicting claims, and conflicts in each case, also ties to improvements. Then write up the notes, giving imaginary bearings from corners and imaginary dimensions to improvements. Do not exclude Surs. Nos. 8733 and 8853 New York and Chicago lodes, and state why.

South Dakota.*

Following is a partial list of questions asked in South Dakota:

1. I run 360 feet on a descent of 1 foot in 15 feet, thence 240 feet on an ascent of 11° from the horizontal, thence 400 feet on a descent of 1 foot in 16 feet, thence 250 feet up an ascent of 35°.

Required total horizontal distance, also difference of level of the initial and terminal points. State a full solution with sketch.

2. From initial point I run S. 12° E. 650 feet, and am intercepted by a pond. From 650-foot point I run S. 82° E., a distance sufficient to clear pond, thence S. 28° W. 420 feet to flag on line in advance of pond, thence S. 12° E. 460 feet to terminal point.

Required the length of line from initial to terminal point. State a full solution with sketch.

3. I run S. 38° E. and at 380 feet turn off a base N. 82° E. 520 feet, from the eastern extremity of which a flag on line in advance of river bears S. 8° E.

What is the distance of flag from initial point? State a full solution with sketch.

4. Course No. 2 of Delta mining claim is broken into by a rock bluff, unfavorable to accurate chainage. To obtain the bearing and length of this line, I run from one

---

*These questions kindly furnished by Prof. Mark Ehle, Rapid City, South Dakota.

extremity on a random line S. 28° E. 610 feet, thence N. 82° E. 260 feet, thence S. 12° W. to a point which from the data so far obtained I find to be on my random line; thence I continue the first random 340 feet further and arrive at a point from which the other extremity of said course No. 2 bears S. 62° W., 110 feet distant.

What is the bearing and length of course No. 2? What angle do I deflect from the course S. 12° W. in order to line in with the first random? State a full solution with sketch.

5. The two extremities of a straight line forming a portion of the boundary of a mining claim are not conveniently accessible, but a convenient base can be had, from each extremity of which both extremities of said boundary can be seen.

1st. Illustrate this condition with sketch.

2nd. State the measurements, both linear and angular, which are absolutely essential to a solution.

3rd. State briefly the trigonometric solution and their respective purposes, with their respective formulæ.

4th. Trace the process to a final resulting course and distance.

A numerical example is not asked.

6. State a convenient formula applicable to what is known as a "broken base," using the number of minutes in the deflection angle of the second component.

7. Given the following consecutive courses of a mining claim:

From Cor. No. 1 to Cor. No. 2, = S. 28° 40′ W. 503 feet;
From Cor. No. 2 to Cor. No. 3, = N. 70° 30′ W. 476 feet;
From Cor. No. 3 to Cor. No. 4, = N. 9° 35′ E. 485 feet;
From Cor. No. 4 to Cor. No. 5, = ? 343 feet;
From Cor. No. 5 to Cor. No. 1, = N. 79° 50′ E. ? feet.

1st. Required bearing of line 4-5 and length of line 5-1.

2nd. If by actual survey of all the sides, it is found that the line 5-1 is N. 79° 55′ E. 395 feet, state a traverse showing the closing errors; then

3rd. Balance the survey on the assumption that the measurements have equal weights.

4th. Deduce the resulting courses and distances of the closing survey for record.

5th. Compute the area of the figure so enclosed, by the method of D. M. D. State full solution with sketch.

8. An incline descends on a dip of 30°. It is determined to sink a shaft to intercept incline, the shaft to be at a point 450 feet from mouth of incline; the surface from mouth to shaft descending at a rate of 1 foot in 75.

How deep will the shaft be?

9. What is azimuth?

10. Observe Polaris at greatest elongation at a place in latitude 45° 30′ N. Apparent of the star is 88° 44′ 10″.

What is the star's azimuth?

State the formula and whole process.

What are the two hour angles corresponding to eastern and western elongations respectively, counting from culmination, round with the sun to 24 hours, and their equivalents in mean solar time?

11. If in the last example the star is observed at eastern elongation and its magnetic bearing at that instant is N. 13° 20′ W.,

What is the magnetic declination?

Is it to be called East or West?

State process and reason therefor.

12. U. S. Revised Statutes (2320) limit lode claims located after May 10, 1872, to 300 feet on each side of the middle of the vein at the surface; suppose you were called upon to make an official survey of such a location under order from this office, and found it to be 350 feet

on each side of the middle of the vein at the surface, and you found nothing in the location certificate to dictate to the contrary; what would be your action in respect to such a location? Why? Suppose such a location was 200 feet on one side of the vein and 400 feet on the other; what would your action be? Why?

13. A lode claim located since May 10, 1872, shows a length of 1,529 feet along the center of the vein at the surface. What would be your action in this case? Why?

14. The boundaries of a lode location have the following consecutive courses, namely:

S. 42° W. 800 feet;
S. 22° W. 600 feet;
N. 80° W. 90 feet;
S. 62° W. 200 feet;
N. 22° E. 600 feet;
N. 42° E. 800 feet;
N. 62° E. 190 feet; thence to place of beginning.

What would your action be on this location if required to make an official survey? Why?

15. I run N. 89° 56' W. on a random line between Secs. 30 and 31, and at 73.20 chains intersect the west boundary of township at a point 22 links north of the corner of Secs. 25, 30, 31 and 36.

1st. What is the course of the return or true line?

2nd. The position of the ¼ section corner?

3rd. State a short rule for obtaining the return course in these cases, applicable when the fallings are within limits, and apply to the above case.

16. An order to officially survey a mineral claim is issued to you from this office under date March 12, 1900; said order is based upon a location certificate dated January 10, 1899. Upon proceeding with survey, you find the location as marked on the ground does not conform to the location as recorded, and upon informing your client

to that effect he provides you with a certified amended certificate of location dated March 30, 1900.

What action would you take in the matter of survey?

17. Describe fully your instrument, stating its make, age and condition; also its capabilities as to power, illumination and graduation, and its attachments of convenience for safe and accurate work.

What measure of length have you?

18. If your telescope has a level, state briefly in writing how you would adjust it and the horizontal hair.

19. The usual method for adjusting the vertical hair in a transit for collimation, may or may not place that hair truly in the center of the telescope. In a well constructed instrument the displacement will be small; in such case, what sensible effect has this displacement upon observations, seeing that the motion of the slide will not project this hair truly along the axis of the telescope?

20. It is required that you determine the true meridian by direct solar observation. You will make the observation in the presence of the examiner, who will then furnish you with a copy of the nautical almanac. From the data then at hand you will make all necessary calculations, handing in the same complete.

21. In latitude 30° N. the sun's declination 20° S. with hour angle 3 hours; the refraction in declination is 8′ 50″.

Assuming no index error, which would be the correct reading to set off on the declination arc, proper for the above date?

22. In latitude 44° N. the hour angle of the sun 6 hours, I start a line due north by solar; but find after running a mile in the course so started, that I have set off 6′ too much latitude.

What is the nature and amount of error in course thus induced?

If in the above the hour angle is 3 hours, what is the nature and amount of error?

If the latitude is correctly set off, but instead of a declination of 10° S. I set off 10° 10' S., the hour angle of the sun being 3 hours, what then is the nature and amount of the error thus introduced?

State, if you can, the differential formulæ applicable to these cases.

California.*

The customary manner of appointment in this and the adjoining states is as follows:

"The surveyor who wishes an appointment, makes application to the Surveyor General, detailing his qualifications. This application, together with the recommendation from some Deputy Mineral Surveyor of good standing within that district, is then forwarded to the Surveyor's General Office, and in due time the appointment is made. The customary filing of the bonds complete the appointment of the U. S. Deputy.

If the Deputy desire an appointment in any other state or territory, I have found that a recommendation from the Surveyor General of the state in which the original appointment was made was all that was necessary to obtain a commission in any additional state or territory. Of course new and separate bonds must be filed for each state or territory in which commission is held."

Oregon.†

The examination in Oregon is about as follows:

1. Fifteen or twenty questions covering the Land Office rulings, the proper markings for corners of government land surveys, the methods of taking latitude by the sun and Polaris, the maximum number of acres allowed in quartz claim, placer and mill site, the kind of corners

*Kindness of Henry J. Jory, Los Angeles, California.

†From H. G. Moulton, U. S. Deputy Mineral Surveyor, Grants Pass, Oregon.

which may be set in making patent surveys, and various details of procedure in executing such surveys.

2. Given the notes of a quartz claim (metes, bounds and ties) and the location of the same, make out notes and preliminary plat of same as if surveyed for patent. This requires the same work to be done that a Deputy would have to do in making out his office work of such a survey.

3. Given the plat of the locations of four claims forming one group, and overlapping each other, with a section corner located on one of the center ones, (this plat is furnished by the Surveyor General), make out notes of a survey for U. S. patent of the group, with plat, calculations, etc. The claims are given on the plat furnished as longer than 1,500 feet and wider than 600 feet, so there is a test of ability in getting them within the required limits and at the same time not leave any fractions.

4. An instrumental examination. Applicant is required to take a transit and determine latitude and meridian by sun and Polaris, checking upon an established meridian, and also to report the courses from a given point to a number of points whose bearing is known.

Parts 2 and 3 are severe tests of applicant's ability, and the examination as a whole is an exceedingly thorough one. It is the aim of the office to get the best available men of the state as deputies, and the examination is in every way a fair one and free from "catch" questions.

While this is all the information that the writer has been able to obtain on the subject of examinations for commission as U. S. Deputy Mineral Surveyor, it is safe to say that in no state is the examination more difficult than in Colorado or Oregon. If the applicant is able to pass the examination in either of these two states, the chances are that he will be able to pass in any state where an examination is held.

APPENDIX.

The following contributed remarks were submitted by a number of engineers and deputies, and appeared in Mining Reporter in discussion of the general subject of Mineral Land Surveying, while this work was appearing in that journal.

Editor Mining Reporter:

Dear Sir—The writer has been greatly interested in your series of articles on Mineral Land Surveying and begs to add a few thoughts on the subject:

The formula which Mr. Moulton proposes in place of the one most generally used would scarcely appear to the writer to be an improvement. It is rarely that the deputy surveyor requires time exactly, but should he desire it he has simply to transpose Mr. MacElroy's formula as follows:

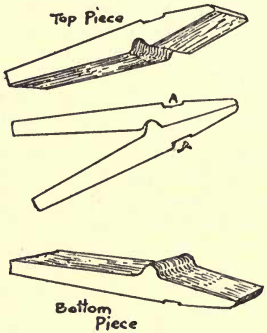
$$\cos P = \frac{\sin a}{\cos d \cos l} - \tan d \tan l.$$

Here he is using exactly the same data as in his calculations for azimuth and looking the angles up on the same line in the logarithm tables. The only additional labor in calculation for time is in setting down the figures. The writer used for many years a formula similar to that proposed by Mr. Moulton, but found that more mistakes were made during the repeated subtractions than at any other stage in the operation. Mr. MacElroy's formula is undoubtedly the simplest so far advanced, especially when many observations are figured at the same time, and being the simplest would seem to be least liable to error.

T. C. H.

Editor Mining Reporter:

Dear Sir—In the January 4th number of Mining Reporter Mr. Underhill, in his article on "Mineral Land Surveying," recommends the use of a pair of parallel pliers to hold the long tape taut and to mark the distance to the axis of the instrument until this measurement can be made and recorded, which makes it necessary for the already overloaded transit man to carry these pliers which are none too light nor convenient in his pocket, and their only advantage over the old method of putting the tape over the shoulder to obtain the necessary pull seems to me to be the fact that they mark the exact distance to the telescope axis. For some time I have used as a tape marker a clothes pin arrangement whittled out of two pieces of wood and shaped something like this:



They are held together by a small rubber band passed several times around both at a-a which furnishes the necessary tension to clamp the marker firmly on the tape, and when not in use it can be clamped for convenience on the watch chain or leather string holding magnifying glass.

This little affair has the added advantage of lightness, can be whittled out in a few moments, and is very convenient to clamp on the tape when a number of measurements of even length are to be made from the same point.

OLD PERPLEXITY.

Editor Mining Reporter:

Dear Sir—In connection with Mr. Underhill's articles on "Mineral Land Surveying," I wish to present another method of reducing slopes of small vertical angles as follows:

Suppose we have vertical angle of 7° 45′ and a slope distance of 292.4 feet. From a table of natural cosines we find cos 7° 45′ = .99087. This means that in 100 feet slope measurement the horizontal component is .913 feet less. (Simply move decimal point and subtract each integer from 9., etc.) For all practical purposes, now, the distance to be subtracted from 292.4 feet is 2.9x.913 or even 2.9x.91 or 2.65. 292.4—2.65=289.75 feet=horizontal.

By logarithms—

log 292.4 = 2.4659774
log cos 7° 45′ = 9.9960149

log 289.73 = 2.4619923

Ordinarily very little figuring is required, as in most cases the work can be done mentally. H. J. A.

DIRECT SOLAR OBSERVATIONS.

Method of Determining the True Meridian.

Mr. Underhill's late articles on the direct solar observation are of great value to the profession, and have been followed by me with a good deal of interest.

In connecting surveys for patent with adjacent mineral surveys, a deputy usually finds in the older surveys alarming discrepancies in the reported courses. This is especially true of the older surveys, made at a time when

solar attachments were not as reliable as at present, and of surveys made during the winter months.

There are certain mathematical principles which lie at the base of astronomical calculations, which must be kept in mind in making observations on either sun or stars. The neglect of one of these is, I think, responsible for most of the errors found in reported bearings derived from solar attachment or direct solar observations.

As pointed out by Mr. Underhill, the formula used for calculating a bearing from an observed altitude of a heavenly body, the latitude and declination being known, is merely a matter of finding one angle of a spherical triangle, the three sides being given. The writer uses a different formula from the one given by Mr. Underhill, as this formula also gives the true local mean solar time, by which the watch may be corrected and used in Polaris observations. The formula is as follows:

Let D be the declination of the sun.

Let H be the altitude (corrected for refraction).

Let L be the latitude of the place.

Then (paying due attention to algebraic signs):

$a = 90 - D$

$b = 90 - H$ $\qquad s = \frac{1}{2}(a+b+c)$

$c = 90 - L$

From these find the auxiliary quantity k as follows:

$$k = \sqrt{\frac{\sin s}{\sin(s-a)\sin(s-b)\sin(s-c)}}$$

Let A be the bearing of the sun (measured from the north point) and T the actual hour angle.

Then

$\cot \frac{1}{2} A = k \times \sin(s-a)$

$\cot \frac{1}{2} T = k \times \sin(s-b)$

The angle A subtracted from 180° gives the bearing of the sun at the moment of observation, and the angle T,

reduced from degrees to hours and minutes, gives the local apparent solar time. By applying the equation of time given in the ephemeris the mean time of the observation is readily found.

All other formulæ, and also a solar attachment in perfect adjustment, which is a mechanical device for solving the same problem, will, from the same data, give the same result and are subject to the same errors.

In northern latitudes, when the sun has a declination south of the equator, or when it is observed near the meridian, the angle (s–a) used in the foregoing formula becomes very small, and an error of a few seconds in it will make a difference of several minutes in the final result. As (s–a) is derived from the declination, the altitude and the latitude, it is apt to be in error a minute or more, since both the altitude and the latitude may be in error by as much as a minute with even the best of field transits used on mineral work.

After calculating sun observations at different times of the day through all seasons of several years, the writer finds the most favorable result to be obtained by taking the sun when due east or due west with an altitude of 25° to 45° above the horizon. The time of the year when this is possible depends upon the latitude. If any deputy doubts the foregoing statements let him observe the sun at 3 p. m., when it has a declination of —10° to —20° (south of the equator), then change his declination and latitude by 1′ each and note the result of the new observation. The statement is true of either direct observation or solar attachment readings.

The writer prefers to check Polaris bearings by a fixed star chosen so that it will be at a convenient point for observation during the months when the sun bearings are not reliable. The fixed stars are more easily and accurately observed than the sun at any time of the year, and as they can be observed at night, do not interfere with the

day's work. It is to be regretted, from an astronomical standpoint, that the government requires solar observations invariably, and will not allow a star to be used instead, as even with any type of telescope solar attachments, observations can be more accurately made upon a star than upon the sun.

Very satisfactory results may be obtained by observing the altitude of some northern star such as those in the constellations Cassiopeia, Ursa Major or Auriga, when near their elongation. The formula used in making the calculations is the same as is used in calculating sun observations, or a Shattuck solar attachment may be used to advantage. The writer has found the Shattuck solar the most convenient for use in star observations, since its adjustments are only those of the transit, and has found its accuracy to compare very favorably with direct observations, though subject, of course, to the mathematical principles pointed out in the foregoing paragraphs.

H. G. MOULTON.

THE PATENTING OF MINERAL LAND.

The layman who desires to secure United States patent on his mining property is not always cognizant of the proper procedure and approximate expense involved and frequently either delays action, fearing that the matter is more formidable than it really is, or else takes unwarranted steps due to his ignorance of all the conditions involved. The following forms have been devised by me with a view of obviating the above mentioned difficulties and I claim that they put the matter of patents in as concise and at the same time as complete a form as the laity can desire.

Preliminary Steps in the Obtainance of United States Patent to Mineral Claims.

1. Obtain from the county recorder a certified copy of the location notice of each claim upon which patent is sought.

2. Deposit in any United States depository to the credit of the treasurer of the United States a sum sufficient to cover the expenses of the work in the surveyors-general office. In this state this is $.....* for lode claims, and $.....* for placers, with reduction for groups.

3. Forward the certified copies of location notices, together with the duplicate certificate of deposit to the United States surveyor-general at....., together with an application for official survey upon a blank issued by the general land office for this purpose, a copy of which may be had at this office.

4. In due time the surveyor-general issues to the deputy named in the application a survey order, in which a serial number is given to the particular survey authorized. This is the deputy's warrant for entering upon any lands necessary in order to make the survey. No survey is official unless in pursuance of an order from the surveyor-general of the district.

5. The United States deputy mineral surveyor designated thereupon makes a complete survey of the premises, locating and fixing the corners of all the claims, locating the discovery points, all the shafts, cuts, tunnels, buildings, and machinery, with reference to the nearest corner of the claim. Also runs ties to the nearest section corners, or ¼ section corners, or if upon unsurveyed land, then to the nearest mineral monument. Assistants must be sworn in to faithful service both before and after the survey, before an officer qualified to administer oaths. Neither the claimants themselves, nor agents thereof, may act as assistants in mineral surveys. An underground survey must generally be made in order to plat the same upon

the map, in plan only. All cornerstones or posts must be up to government standard, and chiseled or scribed with the claim initials, number of corner and survey number.

6. Plat and Field Notes from the Deputy to the Surveyor-General.—These very commonly take double the time of the actual field work, as they must be prepared with absolute accuracy and fidelity to detail as required by the department. They must show, in addition to the data previously mentioned, the distances intersected on all the section lines, complete calculation of areas by double meridian distances, the sectional subdivisions made fractional, the errors found in previous contiguous surveys, and many other minor details.

7. Examination of the Above by the Surveyor-General. —The returns by the deputy must await their turn in the surveyor's-general office before coming up for approval. This may take two or three months, or longer. The returns are then examined by a skilled force of clerks and deputies, all calculations, ties, boundaries, intersections, etc., are rechecked, and the notes and plat searched for irregularities. If any are found, the notes are returned to the deputy for correction, and when again received, must generally await their turn for approval. In extreme cases it has taken several years to obtain the approval of a survey. Three months is above the average time.

8. Upon the approval of the survey, the surveyor-general prepares an approved copy of the plat for each claim in the survey, and three extra copies. One copy is retained, one forwarded to the general land office at Washington, one to the local land office, and the others, with as many transcripts of the field notes, are returned to the claimants. Each plat contains the official approval of the surveyor-general and his certificate of $500 improvements, as returned by the deputy.

Upon receipt by the claimants or their attorneys of the

plats and transcripts, the matter is in shape for the patent application proper.

Method of Procedure in Patent Applications for Lode Claims.

Upon receipt of the approved plats and transcript of notes from the surveyor-general, these are turned over to the attorney engaged to prepare the necessary papers in the case. (United States deputy mineral surveyors are not allowed by the rules of the department to act as attorneys in mineral cases.)

1. There is prepared the **notice of application for United States patent,** according to the specified form, describing the ground claimed. This is prepared in triplicate, and one copy attached to the plat and transcript of notes, is at once posted on the claim in the presence of two witnesses.

These witnesses then subscribe to this posting before notary public, in the form **proof of posting notice and the diagram on the claim.** They also attach their names as witnesses to the **notice of application for patent.** (In the case of groups it is customary and safest to post a **notice and plat at discovery** point of each claim.)

2. There is then prepared by the attorney the following papers constituting the **first set.**

Application for patent in regular form and describing premises.

The abstract of title. (This must be shown to be in applicant.)

The proof of citizenship. (Affidavits showing applicant to be United States citizen.)

Proof of non-abandonment, i. e., that assessment work was done for year preceding the application.

Agreement of publisher. (That he will not hold United States responsible for costs.)

Publication notice. (This is identical with notice of application for patent, except that it is not signed by appli-

cant, but left blank for signature of the register of the district.

3. These papers, together with the extra plat, transcript of notes, and the **proof of posting,** are then filed with the register of the land district, who attaches his signature and the serial number to the **publication notice,** and either delivers same to the attorney or forwards it direct to the printer.

4. This publication notice is published for sixty-one consecutive days in a daily or nine consecutive times in a weekly newspaper. During this time plats, notices and transcripts must **remain posted.**

5. After expiration of period of publication, attorney prepares the **second set** of papers, as follows:

Proof of continuous posting (by two witnesses before notary).

Proof of publication. Certificate from the publisher, giving dates and number of times published.

Proof of no suit pending, attested by clerk of county wherein claims exist.

Proof of sums paid. Made by applicant, detailing amounts paid to deputy, the filing fees, publisher's account, and amount tendered **received** for acreage. Formal **application to purchase.**

The filing of this paper completes the requisites of entry and payment and the register's **proof of posting notice,** and final certificate of entry completes the patent application.

All papers except a copy of the plat are forwarded by the local land office to the department at Washington and patent issues within one year, except in cases of overcrowding the department.

No assessment work need be done after the issuance of the receiver's receipt.

The government price for lode claims is $5 for each acre or fraction thereof.

All affidavits must be made before an officer legally qualified to administer oaths, and with few minor exceptions must be made within the land district.

A corporation may apply, if its citizenship is properly supported. Alien corporations may not patent and sums paid by them are forfeited.

Time required to obtain receiver's receipt, six to eight months after survey.

Any other details desired can be supplied.

Deputy's Estimate to Claimant.

As per request, I am pleased to submit you a detailed estimate of the minimum cost of obtaining United States patent to the following mining claims, viz.: ..... together with a general statement of the method of procedure, which may serve to guide you in the matter.

1. (.....) Certified copies of the location notices—one for each claim—to be obtained from the county recorder at.....† and forwarded to the United States surveyor-general at.....‡ together with an application for official survey, drawn up on a special blank, which can be furnished by this office. This must be signed with the name and address of applicant or his attorney. $.....*

2. This application must be accompanied by a certificate of deposit from any bank, designated as a United States depository, showing that there has been deposited by the claimant, to the credit of the treasurer of the United States, a sum sufficient to cover the cost of office work on plats, transcripts, etc., in the surveyor's-general office. In this state the cost is $.....* for the first claim, and $.....* for each successive claim or fraction. Total, $.....*

No survey order will be issued unless money is deposited and unless application is accompanied by satisfactory location certificates. (See special sheet in regard thereto.)

3. Official survey by United States deputy, including all expenses for traveling, assistants, incidentals, notary fees (all assistants appearing twice under oath in addition to their affidavit of improvements), also all office work on plats and field notes, and full returns to the surveyor-general until the final approval of the survey. $.....*

4. Attorney work, preparation of the patent application and all papers in the case, as listed in the circular entitled "Method of Procedure," including the taking of affidavits and all notary fees. $.....*

5. Abstract of title, as shown by the records of the county recorder, cost depends upon number of claims, number of transfers, etc., and is very variable. In this case about $.....*

6. Publication of the notice of application for patent. This must be advertised in the nearest newspaper to the claim, satisfactory to or designated by the register of the local land office. Amount charged is very variable and is a matter for special contract. About $.....* Sixty-one consecutive days in daily, or nine consecutive weeks.

7. Fees for filing application for patent at the district land office, in this case at.....§ Payment must be made to the receiver when first set of papers are filed. $.....*

8. Proof of posting plats, etc., and proof that plats, etc., have remained posted. Two witnesses must in each case subscribe to these affidavits. Cost is very variable, depending on distance witnesses must cover in going to claim and to notary. About $.....*

9. Certificate of no suit pending, proof of non-abandonment, proofs of sums paid, and miscellaneous affidavits, if necessary. About $.....*

10. Purchase price from United States government for the land. Amount to be paid to the receiver of the district land office by the claimant for the acreage as returned by the deputy. Fractional acres are charged as full acres.

Rate is $5 per acre for lode claims and millsites, and $2.50 per acre for placers. About ..... acres at $.....*

Estimated total, $.....*

If any adverses or protests be filed, costs are at once increased largely, and no approximate estimates can be made.

Notation to Accompany Deputy's Estimate.

Many of the ordinary location notices upon which claims are held are not deemed "sufficient" by the surveyor-general, and survey orders will not be issued upon them without amendment.

Satisfactory location certificates must in general be drawn up after a certain recognized government form, and state with great explicitness the locality and boundaries of the claim. The surveyor-general is authorized to refuse survey orders on notices that are vague, indefinite, faulty, or that will not serve to fix the boundaries of the claim upon the public domain.

Furthermore, the deputy is expressly prohibited from including any ground outside of the original boundaries of the claim, even though said ground may be vacant at the time of survey, and neither side line may be over 300 feet distant from the middle of the vein at the surface. Any attempt to evade these requirements will probably cause a disapproval of the survey, or if successfully evaded in the plat and field notes, the entire application is subject to protest and cancellation in the land office.

This last requirement, together with the well-recognized principle that the end lines must be made parallel, often serves to cut off ground from the claim which can not be included in the patent application.

Very often this ground is valuable and must be made the subject of another survey and application, with its attendant cost.

It is, therefore, **generally advisable,** in all cases where

claims have not already been surveyed for amended location, to first make a preliminary survey of the claims, taking up all fractions and vacant ground, shifting the original locations, if necessary, so that the side lines and discovery point present the proper relations to each other. Formal amended certificates are then filed, disposing of the ground in exactly the manner desired in the patent. A survey order may be at once obtained from these certificates and a survey based upon such re-location generally meets with prompt approval.

None whatever of the original rights are lost by this amendment, but, on the contrary, this simple procedure does away with nearly all of the protests, adverses, apex litigation, and other difficulties attendant upon the exercise of mining rights.

H. J. JORY.

---

*To be filled in in accordance with the list of charges adopted by the surveyors-general in each state or territory.

†County in which claim is located.

‡Capitol of state or territory.

§Land district office in state or territory.

TRIANGULATION SURVEY
IN
CLEAR CREEK COUNTY, COLORADO.

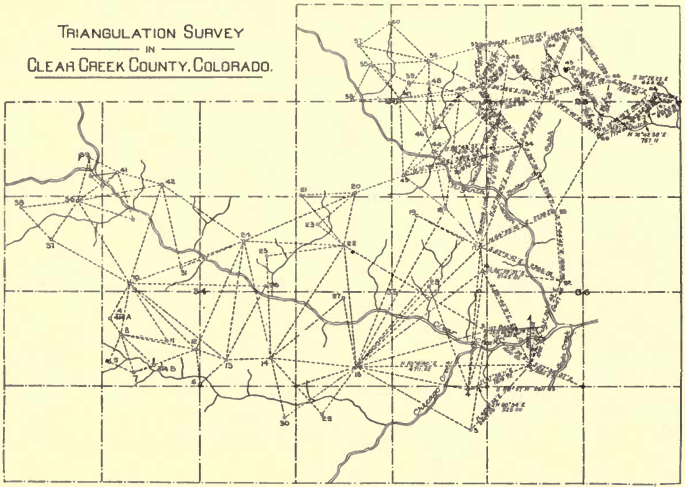
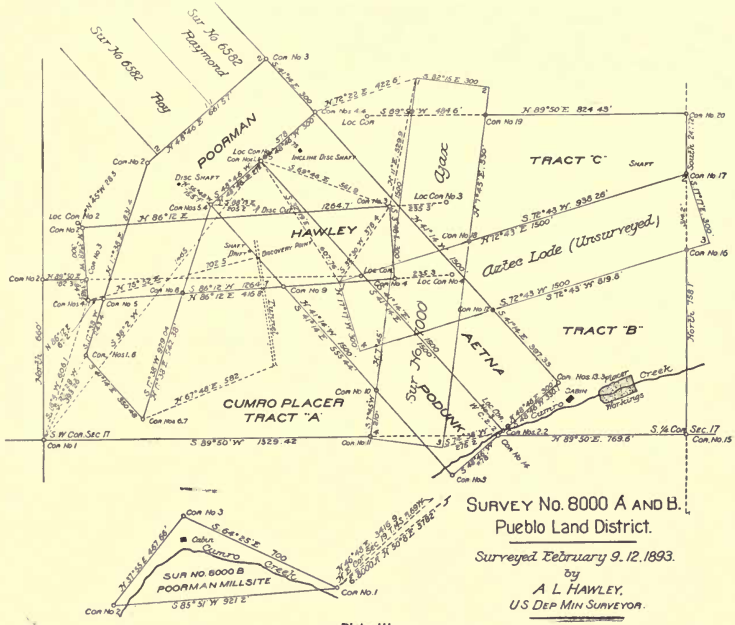


PLATE I.

INDEX TO TRIANGULATION.

From.	To	Course.	Dist.	North.	South.	East.	West.	DESCRIPTION.
S.E.Cor. Sec.24	1	N.75° 24' 55" E.	5894.35	1519.88		6701.46		E. End of first base in Main St., Idaho Springs.
S.E.Cor. Sec.24	3	N.75° 44' 10" E.	6373.63	1504.92		6158.48		W. End of first base in Main St., Idaho Springs.
S.E.Cor. Sec.24	3	N.34° 43' 13" E.	6372.13	586.33		6345.11		On Montague Hill, E. of reservoir.
S.E.Cor. Sec.24	4	S.88° 49' 01" E.	4859.25		35.19	4858.35		On N. spur of Flirtation Hill.
S.E.Cor. Sec.24	5	S.75° 45' 26" E.	4930.47		1199.15	4780.86		On Summit of Flirtation Hill.
S.E.Cor. Sec.24	16	N.55° 05' 13" E.	5954.00	3147.50		5064.05		On S. End of Hill W. of mouth of Virginia Canon.
S.E.Cor. Sec.24	17	N.52° 45' 00" E.	5290.22	3207.43		5007.03		On Summit of Hill W. of mouth of Virginia Canon.
E.¼ Cor. Sec.25	32	S.32° 26' 18"W.	5852.44		4907.86			On Woody Hill E. of mouth of Virginia Canon.
E.¼ Cor. Sec.25	33	S.46° 32' 32"W.	4659.87		3013.12		3261.25	On Hill E. of mouth of Buttermilk Gulch.
E.¼ Cor. Sec.25	34	S.74° 13' 30"W.	4489.76		1230.79		5418.09	On Ridge between Seaton and Buttermilk Gulch.
E.¼ Cor. Sec.25	35	S.73° 33' 04"W.	6363.33		1803.61		4320.56	On S. End of Ridge between Seaton and
							6102.35	Boomerang Gulches.



SURVEY No. 8000 A AND B.
Pueblo Land District.

Surveyed February 9. 12. 1893.
by
A L HAWLEY.
U.S. DEP. MIN. SURVEYOR.

Plate III.

TN
273
U5

THE LIBRARY
UNIVERSITY OF CALIFORNIA
Santa Barbara

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW.

3 1205 00483 5144

UC SOUTHERN REGIONAL LIBRARY FACILITY
AA 000 105 698 5